PRODUCT IMPROVEMENT AND ADVANCED PRODUCTION ENGINEERING OF THE M550 FUZE

Final Report

By

G. T. Keller

March 1974

Picatinny Arsenal
Dover, New Jersey 07801

Avco Precision Products Division
Richmond, Indiana 47374

CONTRACT DAAA21-72-C-0566

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--      FABRICATE AND DEBUG A PROTOTYPE M550 FUZE ASSEMBLY LINE THAT WILL
--         <<P FOR NEXT PAGE>> OR <<ENTER NEXT COMMAND>>
y                                              *MSG RECEIVED*
1a ROW=24 COL= 01          <Ctrl>H For Help                          N  Poll
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AVCO

PRECISION PRODUCTS DIVISION
SHERIDAN STREET, RICHMOND, INDIANA 47374/(317) 962-5511

4 June 1974

Department of the Army
Hq., Picatinny Arsenal
Dover, New Jersey 07801

ATTENTION: SARPA-AD-E-B-4

SUBJECT: Contract DAAA21-72-C-0566
Approved Final Summary Report

REFERENCE: SARPA-AD-E-B2 Approval Letter 30 May 1974

Distribution of the Final Summary Report is made herewith in accordance with the requirements of Contract Data Item A004:

Distribution:	No. of Copies
Picatinny Arsenal, SARPA-AD-E-B-4	2*
SARPA-QA-A-S	2
SARPA-TS-T-S	5
Defense Documentation Center, Alexandria, Va.	12
DCASD, Indianapolis, DCRI-DICC	2
Project Manager for Selected Ammo., AMCPM-SA	1
U.S.Army Materiel Command, Wash.,D.C., AMCRD-WC	1

John S. Slavich
Contract Manager

Encl. a/s

*One (1) Copy Handcarried Week of 13 May 1974

Report Drawer

PRODUCT IMPROVEMENT AND ADVANCED PRODUCTION ENGINEERING OF THE M550 FUZE

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By

G. T. Keller

March 1974

Picatinny Arsenal
Dover, New Jersey 07801

Avco Precision Products Division
Richmond, Indiana 47374

CONTRACT DAAA21-72-C-0566

ABSTRACT

This is the final report on progress achieved on the M550 Fuze Product Improvement Program, Contract No. DAAA21-72-C-0566, during the period from April 1972 through February 1974.

The objective of the program was to design, develop, fabricate and debug a prototype M550 Fuze assembly line that will be capable, when balanced, of producing 250,000 fuzes per month on a 1-8-5 shift basis. This contract did not require that the line be balanced for a true 1-8-5 shift basis at this time.

The prototype line was acquired and installed, with production beginning on a separate contract almost immediately.

Appendices are included covering a verbal description of each machine's function; a sample purchase description; listing of operation and maintenance manuals; and a list of drawings for the assembly and test machines.

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SECTION I

CONTRACT REQUIREMENTS

The requirements to be fulfilled during the contract time frame are as follows:

a. Conduct an analysis to determine comparative risk, yield, and cost of conversion of existing equipment for the production of M551 Fuzes as compared to the design and fabrication of new equipment for the production of M550 Fuzes. A report of the conclusions of this analysis is to be submitted to the Contract Project Officer.

b. Explore fuze assembly techniques to assure production of a uniform product and make every effort to eliminate the necessity of selecting components for individual fit.

c. Conduct a study to determine if the components, subassemblies, and assemblies can be fabricated or assembled by mechanical and/or automated equipment.

d. Submit a preliminary equipment list to the Contract Project Officer including estimated cost of all proposed standard and special equipment, tooling, and gages required to meet the contract objectives.

e. Submit a complete breakdown of each item of special tooling, equipment, and gages to the Contract Project Officer to include:

   1. Engineering and design considerations

   2. Design calculations

   3. Design sketches

   4. Preliminary amortization study

   5. Anticipated development or application problems

   6. Estimated time to fabricate the prototype line and have it operational.

f. Provide Category E, Form 3, Government Design Activity Drawings of the final approved design of the prototype line.

g. Submit final item specifications or inspection plans and a complete list of all military and commercial specifications.

h. Submit the complete design of acceptance inspection equipment.

i. Take any corrective action required as disclosed by the engineering tests of the items fabricated, as directed by the Contract Project Officer.

j. Conduct an 1100-round proof test to verify that an overall fuze functioning performance rate of 95 percent reliability factor at a 90 percent confidence level is attained.

k. Prepare and submit a final technical report to the Project Contract Officer that includes a description of operation procedures and maintenance manuals of the entire M550 Fuze line, a set of prints of the final set of component drawings and inspection equipment, and a list of all specifications.

l. Up-date the Technical Data Package of the M550 Fuze.

m. Comply with the following target dates:

1.	Fabricating Equipment	March, 1973
2.	Install and Debug Assembly Equipment	April, 1973
3.	Proof Test	May, 1973
4.	Final Report	July, 1973

SECTION II

TECHNICAL DISCUSSION

At the date of this report, the general M550 Fuze production area remains as shown in Figure 1, and the automated assembly layout is shown in Figure 2. It should be noted that additional operators have been added to provide hand banking between machines, and to allow for the extra attention required during the first few months of operation while machine debugging is still in progress. Eventually, mechanical banking is desirable as an economical substitution for the manual banking now in use. The overall schedule of completion dates for design, fabrication, and debugging of the individual assembly machines is shown in Figure 3.

ASSEMBLY MACHINE RATES

With the objective of providing an assembly line capable of producing 250,000 fuzes per month on a 1-8-5 shift basis, the Purchase Description for Equipment (PDE) was originally prepared with the assumption that at the end of the production line an average yield of 1563 good fuzes per hour is required. This assumes 20 working days per month at 8 hours per day. Also, the PDE was based upon an overall machine utilization factor of 80 percent. Therefore, this represents the rates specified for gross machine cycle rate and net yield per hour. These values are shown in the first two columns of Table I for each of the eight new machines acquired under this contract. Figure 4 shows a block diagram for the automated line indicating desired input, output, and reject rates for each assembly machine.

A more accurate approach to individual machine requirements is obtained by considering the actual flow of parts and subassemblies, together with the expected fallout at each machine, caused primarily by either bad parts or a machine malfunction. These net output rates, together with optimistic reject percentages, are shown in the third and fourth columns of Table I. Verge and Pinion Assembly machines operate independently from the remainder of the assembly line, and feed parts into the Escapement Assembly machine as does the Rotor Assembly machine. Therefore the rates for all three machines should be at least the minimum required to supply the Escapement Assembly machine, or 1899 good assemblies per hour.

The performance of the individual machines during the acceptance runs, both at the vendor's plant and at Avco's Richmond plant, gave some indication of the potential capabilities compared to the desired yield. These figures are shown in the last two columns of Table I.

In general, the acceptance run yield was reasonably close to that desired. However, these runs were of relatively short duration, and in almost all cases the parts were carefully screened in an effort to minimize down time caused by parts, and thus accentuate any machine deficiencies. As soon as production runs were started and parts screening was reduced to a more economical level, long periods of down time were experienced and the actual yield per day was greatly reduced. Much of this was expected as a natural consequence of continued machine debugging, training of operator, setup and maintenance personnel, and subtle but important changes in parts that had adverse effects on automated assembly.

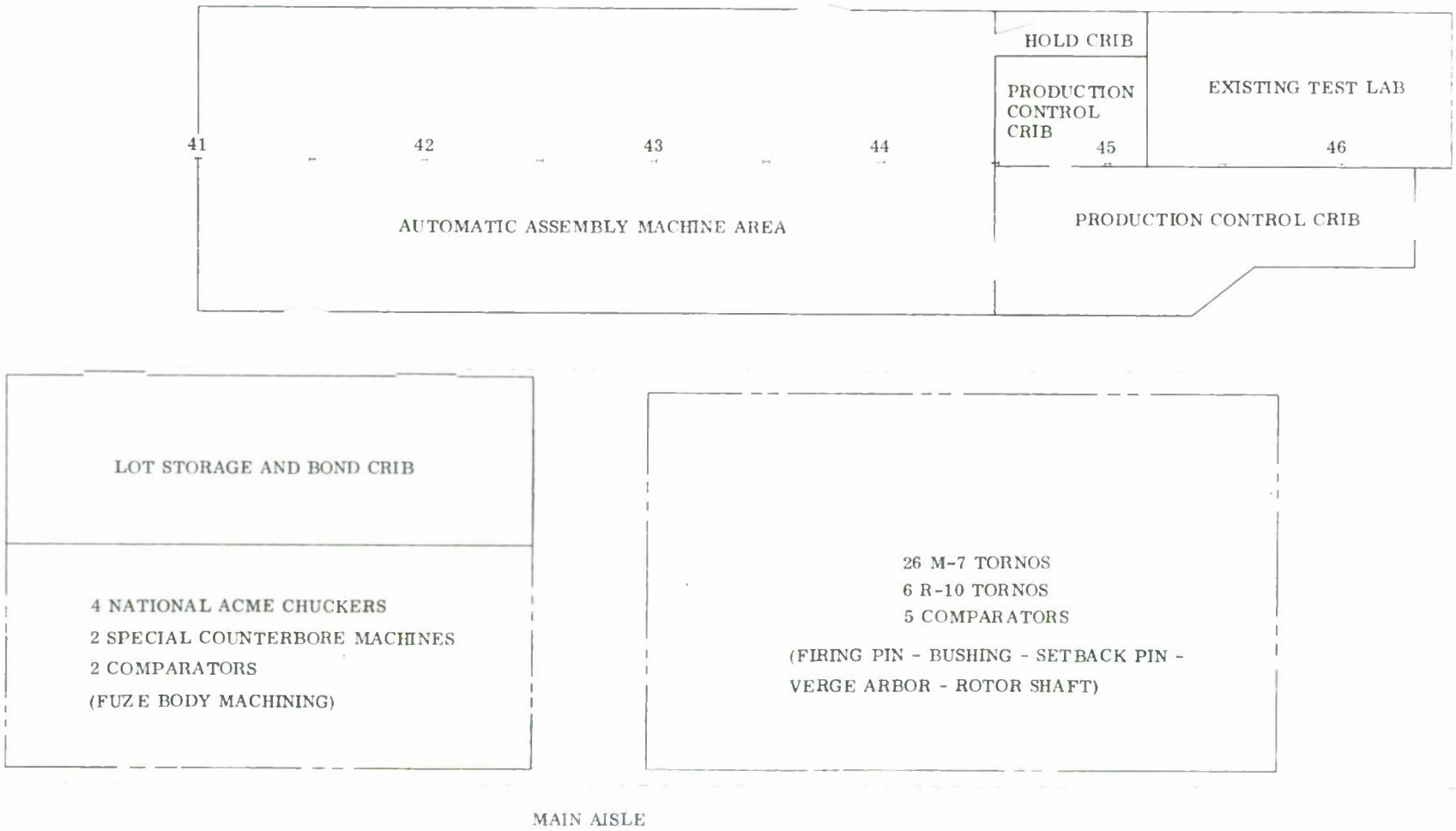


Figure 1. General Floor Plan for M550 Fuze Production Area

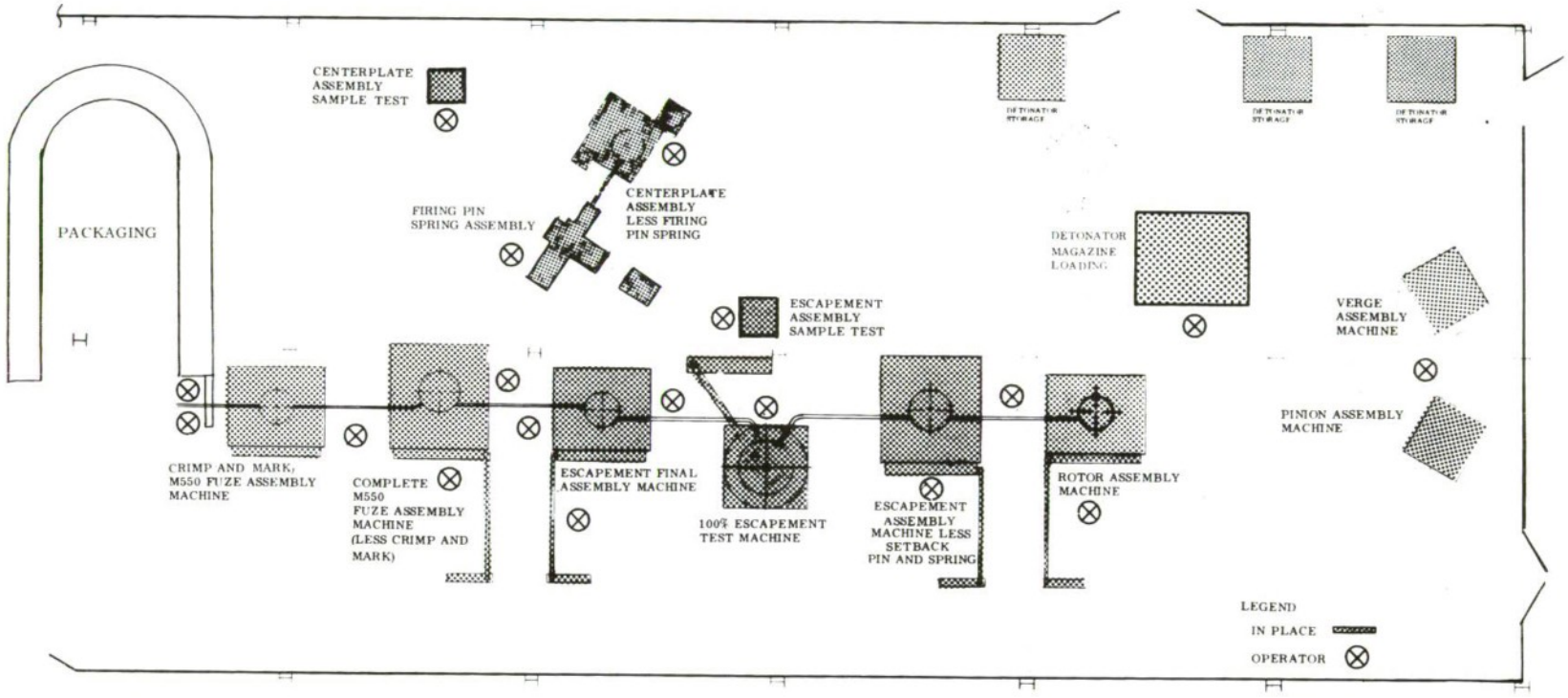
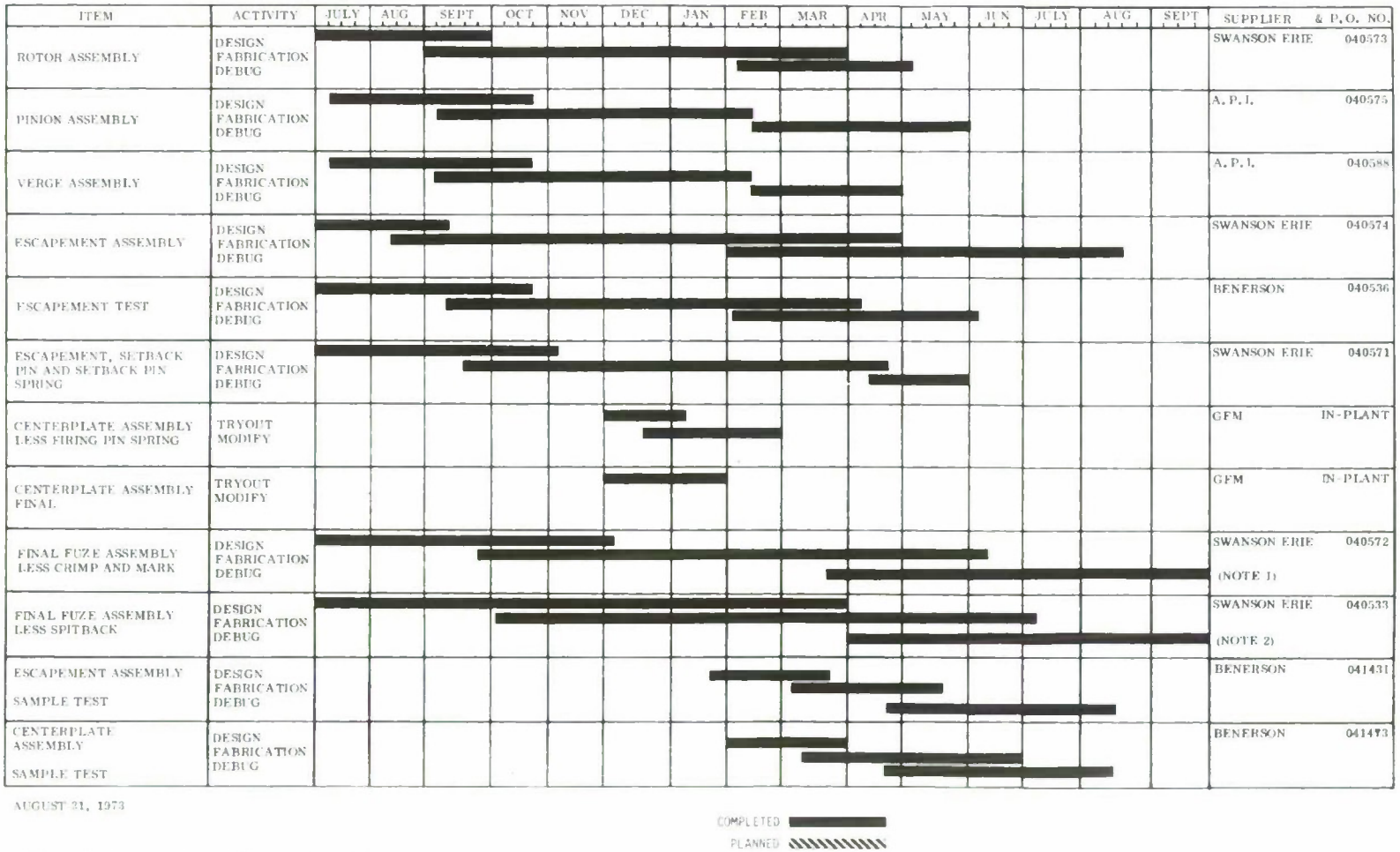


Figure 2. M550 Fuze Automated Assembly Layout



NOTE 1 - FINAL PAYMENT FOR THIS MACHINE AUTHORIZED DURING JANUARY 1974.

NOTE 2 - THIS MACHINE WAS ACCEPTED BY AVCO AND FINAL PAYMENT MADE TO THE VENDOR ON 28 NOVEMBER 1973.

Figure 3. M550 Fuze Prototype Assembly Line Schedule

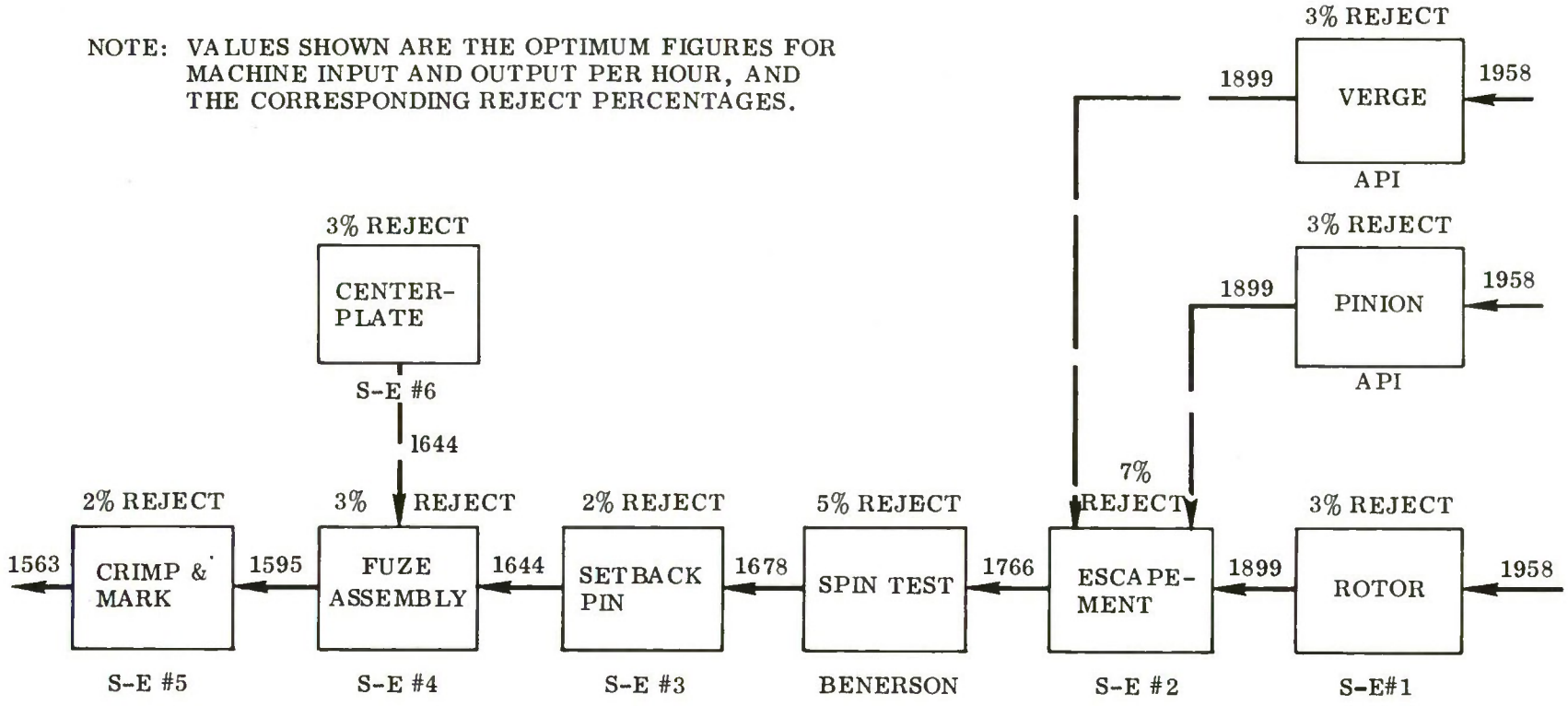


Figure 4. Block Diagram of M550 Fuze Automated Assembly Line

TABLE I. AUTOMATIC ASSEMBLY MACHINE RATES

Assembly Machine	Purchase Description		Desired Yield For Net 1563/Hr.		Acceptance Runs	
	Gross Rate/Hr.	Net Rate/Hr.	Net/Hr.	Reject %	Net/Hr.	Reject %
Verge	2000	1600	1899	3	(R) 1970	6
Pinion	2300	1840	1899	3	(R) 1880	5
Rotor	2300	1840	1899	3	(R) 1850	1.5
Escapement	2300	1840	1766	7	(A) 1735 (R) 1450	10.0 7.3
Escapement 100% Spin Test	2300	1840	1678	5	(R) 1837	6.6
Escapement Final Assembly	2100	1680	1644	2	(R) 1700	3.3
Fuze Assembly, Less Crimp & Mark	2300	1840	1595	3	(A) 1830 (R) 1656	5.0 10.1
Fuze Crimp & Mark	2000	1600	1563	2	(A) 1800 (R) 1800+	1.5 1 to 2*

*—No Formal Run
(R)—Richmond
(A)—Anaheim

It also became apparent that the gross rate of the Escapement Assembly machine was limited to about 1920 per hour, and the Fuze Assembly machine was limited to about 1800 per hour. This condition requires banking capability both ahead of and behind the Escapement Assembly machine, and just ahead of the Fuze Assembly machine to bring the interconnected machines to a higher capacity. The original design for the automated line required adequate banking at these three locations to provide the yield of 500,000 fuzes on a 2-8-5 basis. Each bank was to have capacity of at least one hour's production, and thereby make provision for all except major breakdown of the individual machines in the line.

ASSEMBLY MACHINE IMPROVEMENTS

In recent weeks, numerous changes have been made to improve the machines, by both Avco and the original supplier. Some of these improvements are covered by drawing changes already submitted, and others are in process. Therefore, a brief discussion, by machine, is given in the following paragraphs to highlight problem areas for which corrective action has been or is to be applied. Since the new automated line will be operated by Avco personnel through June, 1974, there will certainly be other improvements either made or for which a need is indicated by that time. It would be advisable for Government technical representatives to

review the assembly line status prior to completion of production, to transmit as much information as possible to the organization who will be operating the line after Avco Precision Products Division ceases. An effort is being made to keep the equipment drawings updated as revisions and improvements are made. This effort is to continue as long as the automated line is in production. The most recent equipment drawings were sent to Picatinny Arsenal on 10 December 1973.

VERGE ASSEMBLY AND PINION ASSEMBLY MACHINES

A monitor light was installed outside the control panel of each machine to permit easier setting of limits at the gaging stations.

ROTOR ASSEMBLY MACHINE

A larger diameter air supply piping system and more flow valves have been added to increase air flow and improve the staking operations.

The detonator staking tool has been changed from a 3-point to a 4-point stake.

Additional trouble lights are desirable at a location above the machine to indicate, from any position around the machine, which station has a stoppage. (This same comment applies to all of the Swanson-Erie machines.)

A separate safety light is planned to indicate if a live detonator has been left in a magazine ready to be discarded. When a detonator is sensed, the machine will stop so that the hazard can be removed.

ESCAPEMENT ASSEMBLY MACHINE

Servicing of the spring winder is awkward, in that it is necessary to climb onto the bed of the machine for either checkup or maintenance. The mounting should be revised so that the entire spring winder assembly can be slid or rotated to a more accessible position. Because of the time required to make this change, it is not planned while current production output is needed.

Ideally, the wire should be wound by the supplier onto the same spool that will be used in the assembly machine, with a minimum diameter of at least 15 inches. Also, if the spool is mounted on the machine with its rotational axis horizontal rather than vertical, the tendency to kink the wire may be reduced.

Deformed or damaged housings have been a consistent problem requiring constant attention.

Inverted verge assemblies have been a recent factor in causing duds during firing tests.

A spring-loaded return feature was added to the cover plate probe station.

At the rotor shaft insertion station, three ejector pins are used in place of the original two, providing improved alignment accuracy.

A spring-loaded pin was added at the rotor assembly placement station to cam the sector gear into the full safe position in the nest.

ESCAPEMENT 100 PERCENT SPIN TEST

At operating rates above approximately 1650 cycles per hour, when the driving motor is shut off the table coasts beyond the next station and the logic is out of sequence. A quotation has been received from Benerson Corporation for a brake to be added to the drive shaft to remedy this condition.

The outlet chute has a modified S-curve in the vertical plane to raise the outlet level to that of the vibratory feeder lines that interconnect the machines. There has been some difficulty with the vibratory feeder being unable to remove the parts reliably. A mechanical transfer is contemplated as a substitute interconnection.

An access door is being added to Station No. 7 to provide for easier cleaning and servicing.

FINAL ESCAPEMENT ASSEMBLY (SETBACK PIN AND SPRING)

Variation of nest heights above the rotating table was excessive, so they were adjusted to make them more uniform.

A new station is being added prior to the final pick and place station to probe for presence and proper orientation of the setback pin, in addition to the probe for the presence of the setback pin spring.

FUZE FINAL ASSEMBLY

One of the more acute problems on this machine occurs when the centerplate assembly is placed on top of the escapement assembly. Although the rotational alignment is accurate at the instant of placement and release, the firing pin spring has sufficient strength to raise the entire centerplate assembly so that it rests on the three long legs of the firing pin spring. Some jiggling and bouncing occurs, sometimes resulting in a rotation out of position. Even though this condition is detected by the probe just prior to crimping, the machine cycle is lost for production because the parts are rejected and must then be handled as salvage. A pre-stake operation has been designed to hold the centerplate assembly in position by pushing three small dimples in the top of the fuze body to prevent any upward movement due to the firing pin spring, and to add sufficient friction to prevent rotation within the fuze body. This supplemental device has not been added at the time of this report.

The O-ring feeder bowl is very sensitive to misshaped parts, so considerable care is required during application of the dry libricant and subsequent handling so that the parts are not deformed.

Occasional difficulty has arisen in maintaining proper positioning of the ogive between the time of placement and eventual crimping on the next machine. Some consideration was given to a precrimp operation at the original placement station, but maintaining a slight interference condition between the ogive and O-ring has made this unnecessary. Addition of the three dimples to the ogive, as permitted by option on the drawing, will insure good orientation of the ogive.

FUZE FINAL ASSEMBLY (CRIMP AND MARK)

The original cams for operating the crimping head were too soft, and have been replaced by the vendor (Swanson-Erie).

Some modification of the crimping head may be required to provide more adjustment in the crimp depth with the same amount of crimping force.

At present, if the probe on the crimp station senses incorrect ogive placement, no crimping is performed. However, the uncrimped fuzes are ejected with the crimped ones. This requires that the uncrimped fuze assemblies be identified and separated manually, either by the machine operator as the condition occurs or by the inspector who examines fuzes coming from the machine. Therefore, it is highly desirable to add an automatic ejection feature for uncrimped fuzes.

SECTION III

TESTING OF M550 FUZES FROM THE AUTOMATED LINE

Before production began on the automated assembly line for the M550 Fuze, several functional tests were performed to verify the quality and effectiveness of the end product. Chronologically, these were:

First Article Inspection on Contract DAAA21-72-C-0852 for Fuze, PIBD, M550 Less Spitback.

Ballistic Test of 424 fuzes on Contract DAAA21-72-C-0852.

Proof Test of 400 fuzes on Contract DAAA21-72-C-0566.

Each of the tests is reported separately. For the First Article Inspection, the last page of the data indicates corrective action taken by Avco to correct the three deficiencies listed.

The Ballistic Test was an informal test conducted to provide advance information as to whether or not an acceptable Proof Test could be expected. Results were exceptionally good, without a single failure.

The Proof Test was performed as part of the contractual obligation of contract DAAA21-72-C-0566.

FIRST ARTICLE INSPECTION

Reproduction of the First Article Inspection correspondence and data are given on the following pages.

DEFENSE SUPPLY AGENCY
DEFENSE CONTRACT ADMINISTRATION SERVICES DIST., INDIANAPOLIS
USSA BUILDING 1
FORT BENJAMIN HARRISON, INDIANA 46249

IN REPLY REFER TO DCRI-BTSCN

1 August 1973

Avco Corporation
Precision Products Division
Sheridan Street
Richmond, Indiana 47374

ATT: Mr. W.D.Smith
Manager,Quality Control

This Office has received supplemental report number 130A-73 from Picatinny Arsenal indicating the status of the various components and sub-assemblies submitted by your Corporation for First Article Inspection on Contract DAAA21-72-C-0852 for Fuse,PIBD,M550 less spitback for 4031.

Attached is a copy of this report for your information and action. Your attention is directed to page 5 of 5 which is a summary of failures encountered and the required corrective action.

Acceptance inspection will be with-held by this Office on the following component parts,Rotor,Slotted 198687, Housing Escapement 198703, Pinion 198646 until corrective action has been accomplished .

It is requested that a reply be forwarded to this Office no later than 8 August 1973 indicating the corrective action you intend to take in order to prevent recurrence.

Sincerely Yours,

W T Cassady

W.T.Cassady,Supervisor
Quality Assurance Specialist

DCRI-DIOON 1 August 1973

AVCO Corporation
Precision Products Division
Sheridan Street
Richmond, Indiana 47374

ATT: Mr. W.D.Smith
Manager,Quality Control

This Office has received supplemental report number 130A-73 from Picatinny Arsenal indicating the status of the various components and sub-assemblies submitted by your Corporation for First Article Inspection on Contract DAAA21-72-C-0852 for Fuse,PIBD,M550 less spitback for 40MM.

Attached is a copy of this report for your information and action. Your attention is directed to page 5 of 5 which is a summary of failures encountered and the required corrective action.

Acceptance inspection will be with-held by this Office on the following component parts,Rotor,Slotted 198687, Housing Escapement 198703, Pinion 198646 until corrective action has been accomplished .

It is requested that a reply be forwarded to this Office no later than 8 August 1973 indicating the corrective action you intend to take in order to prevent recurrence.

Sincerely Yours,

W.T.Cassady,Supervisor
Quality Assurance Specialist

1. U. S. Army Munitions Command
First Article Test Summary Report

Picatinny Arsenal
Dover, New Jersey 07801

RCS. SMUQC 111

2. Date	3. Report No.
JUL 25 1973	150A-73

4. In reply refer to	5. Preliminary ☐ Supplemental ☒ Final ☐
SMUPA-QA-I-Q	

6. To

DCASR, Indianapolis
Bldg. 1 FCUSA
Ft. Benjamin Harris
Indianapolis, Indiana 46249

7. Date initial production sample received at Richmond, Indiana (insert location)
Date 10 July 1973

8. Contract No. DAAA21-72-C-0352

9. Contractor AVCO Corp. Precision Products Division

10. Complete sample ☐
Partial sample ☒

11. Item nomenclature
Fuze, PIBD, M550 Less Spitback for 40 MM

12. Quantity
As Per Contract

13. Inspection in accordance with
AVCO Inspection Procedures and Contract

14. Name(s)

15. Representing

16. Inspected by
C. A. Nassuccio

17. Submitted by
A. Siegfried/db/201-328-2458

18. Recommendations to Procuring Activity

☐ The contractor may proceed with production.

☐ The contractor may proceed with production provided the deviations cited under Remark of block 28 are corrected.

☐ Corrective action cited on block 28 is required

☒ See Action to be taken cited in Block 28.

19. Distribution
MUCOM/AMSMU-Q/171
AMSMU-RR/171
AMSMU-PP-IMMP/Joliet, Il
AMCPM-SA
Cy Furn: AVCO Prec. Prods Div.

20.

John J. Hart
JOHN J. HART
Chief, Qual Eval Br

SMU FORM 1031-R AUG 66 REPLACES AMSMU 142-R WHICH MAY BE USED

SHEET 1 OF 5

21. Item/Part Nomenclature	22. Part No.	23. Serial No.	24. Specification No.	25. Specification Paragraph No.	26. Identification	27. Test Poss	27. Test Fail
100 Each Star Wheel (Hamilton Tech., Inc.)	198510 REV N	N/A	AVCO Insp. Procedure	198510 198510	Cert. for Mat. Cert. for Prot. Finish	x x	
100 Each Spring, Detent (Swanson-Erie)	198679 REV D	"	"	198679 198679 " "	Examination Cert. for Mat. Cert. for Prot. Finish Load Test	x x x x	
100 Each Rotor, Slotted (American Powdered Metals)	198687 REV E	"	"	198687 "	Examination Cert. for Mat.		x x
100 Each Gear, Sector (Roller Die & Tool Co.)	198659 REV T	"	"	198659 " " "	Examination Cert. for Mat. Cert. for Prot. Finish	x x x	
110 Each Verge Assembly (AVCO Prec. Prod. Div)	198649 REV G	"	"	198649 " "	Examination Cert. for Mat. Static Load Disassembly Test	x x x	

SZU FORM 1031-R AUG 66 REPLACES AMSMU 142-R WHICH MAY BE USED

SHEET 2 OF 5

21. Item/Part Nomenclature	22. Part No.	23. Serial No.	24. Specification No.	25. Specification Paragraph No.	26. Identification	27. Test Pass	27. Test Fail
110 Each Pinion Assembly (Avco Prec. Prods. Div)	198647 REV G	N/A	Avco Insp Procedure	198647 " "	Examination Cert. for Mat. Static Load Push Off Test	x x x	
100 Each Spring Firing Pin (Koller Die & Tool Co.)	198729 REV A	"	"	198729 " "	Examination Cert. for Mat. Cert. for Prot. Finish	x x x	
100 Each Spring Hammerweight (KIFDC, Inc.)	198726 REV B	"	"	198726 " "	Examination Cert. for Mat. Cert. for Prot. Finish	x x x	
100 Each Pinion (Cam Development & Micro Component Inc.)	198646 REV E	"	"	198646 " "	Examination Cert. for Mat. Cert. for Proti Finish		x x x
100 Each Center-Plate (Koller Die & Tool Co.)	198686 REV H	"	"	198686 " "	Examination Cert. for Mat. Deflection Test	x x x	

SMU FORM 1031-R AUG 66 REPLACES AMSMU 142-R WHICH MAY BE USED

SHEET 3 OF 5

21. Item/Part Nomenclature	22. Part No.	23. Serial No.	24. Specification No.	25. Specification Paragraph No.	26. Identification	27. Test Pass	27. Test Fail
100 Each Plate, Top (Koller Die & Tool Co.)	198547 REV B	N/A	AVCO Insp Procedure	198547	Examination	x	
				"	Cert. for Mat.	x	
				"	Cert. for Prot. Finish	x	
100 Each Verge (Koller Tool & Die Co.)	198648 REV G	"	"	198648	Examination	x	
				"	Cert. for Mat.	x	
100 Each Housing Escapement (Hackon Inc.)	198703 REV G	" 3850 -72-085-05	"	198703	Examination		x
				"	Cert. for Mat.	x	

SMU FORM 1031-R AUG 66 REPLACES AMSMU 142-R WHICH MAY BE USED

SHEET 4 OF 5

28. Summary of failures encountered and required corrective action.

1. Rotor, Slotted - Dwg. 198687

The protective finish was omitted from all pieces.

Unlisted Defect

2. Housing, Escapement - Dwg. 198703

The .043 ±.002 dimension measures .001 to .002 above maximum limit. on all pieces.

Unlisted Defect

3. Pinion - Dwg. 198646

There are burrs in the root diameter of the teeth on all pieces.

Defect #201

Action To Be Taken:

1. The contractor take corrective action on the defects noted above in paragraphs 1, 2 and 3 to the satisfaction of the QAR.

2. Final evaluation will be made upon the submission of the balance of the First Article Sample at the contractor's facility.

SMU FORM 1031-R AUG 66 REPLACES AMSMU 142-R WHICH MAY BE USED SHEET 5 OF 5

AVCO PRECISION PRODUCTS DIVISION
SHERIDAN STREET, RICHMOND, INDIANA 47374, TELEPHONE: (317) 962-5511

23 August 1973

Mr. W. T. Cassady
Quality Assurance Specialist (DCAS)

Subject: Answer to Your Letter 1 August 1973, First Article M550
Contract No. DAAA21-72-C-0852

The three items in question have been investigated and the following action is being taken.

1. Slotted Rotor 198687

   No finish on rotor, ECP-72-0852-047 has been approved by Picatinny Arsenal to remove protective finish.

2. Housing Escapement 198703

   The .043 + .002 dimension checks +001 to +002, ECP 72-0852-052 has been approved by Picatinny Arsenal requesting the 043 + 002 change to 043 + .004.

3. Pinion 198646

   Burr in root of teeth from Cam Development. P. Sherman and G. McNutt contacted the vendor and he agreed that he will correct the condition, new lot expected at Avco 8-20-73. The part in house will be deburred and resubmitted for inspection prior to assembly.

W. D. Smith
Quality Control Manager

BALLISTIC TEST

BALLISTIC TEST ON 424 M550 FUZES PRODUCED ON AVCO'S AUTOMATED ASSEMBLY MACHINE

Tests were conducted on 424 M550 Fuzes built on Avco's automated M550 Fuze line. Escapements were built, removed from the assembly line, time tested on R&D equipment and returned to the assembly line for reasons of numbering. The number of escapements total 500 of which 424 were for testing. The escapements were then assembled into M550 Fuzes and marked so that the time could be associated with the complete M433 round when gun fired for non-arm purposes.

Four hundred of the M550 Fuzes mentioned were packed in the regular shipping containers and subjected to Transportation-Vibration, MIL-STD-331, Test 114, Table I only. X-rays indicated that Transportation-Vibration had damaged 17 hammerweight assemblies by breakage of the hammerweight spring. These 400 fuzes were then assembled into complete M433 rounds with inert cup and skirt assemblies and HE loaded spitbacks. One hundred and fifty rounds were gun fired from an M203 Launcher at ambient conditions onto armor plate with a thickness of 2 inches at 125 feet. The results of this gun firing was 100% function.

One hundred and fifty of the above mentioned fuzes were gun fired from the M203 Launcher at ambient conditions onto gravel no greater than 1/2 inch in diameter and a thickness of at least 6 inches at 200 meters. The results of this gun firing was 100% function. Fifty of the remaining 100 rounds were used for the non-function testing. This test consisted of gun firing at a target of 16-gauge steel backed by 3/4-inch plywood at a range of 45 feet. Rounds were gun fired from an M203 Launcher at ambient conditions. The results of this test were no fuze functions. If two or more functions had occurred, the test would be repeated with the remaining 50 rounds. The escapement times for the above mentioned test averaged 257 milliseconds with a high reading of 283 milliseconds and a low reading of 235 milliseconds. The average escapement time reading for the 500 escapements initially mentioned averaged 257 milliseconds with a high reading of 287 milliseconds and a low of 235 milliseconds. All times stated above were obtained from the R&D time machine.

Twenty-four additional rounds were built into M433 rounds with live HE loaded spitbacks and inert cup and liner assemblies to be used for Jolt and Jumble. Results of the Jolt and Jumble by X-ray and tear-down of these rounds indicated that all escapements were in the full safe condition after testing, although damage did occur to the hammerweight assemblies.

BALLISTIC TEST RESULTS - CONTRACT DAAA21-72-C-0852

Four hundred and twenty-four fuzes were selected from approximately 1000 fuzes assembled and checked by the automatic assembly and test machines. Four hundred were packed in the regular shipping container and subjected to Transportation-Vibration with the fuzes X-rayed after the Transportation test. Three hundred and fifty fuzes were then assembled to HE spitbacks and inert cup and liner assemblies for gun firing.

TESTS CONDUCTED

Minimum Arm Test:	45 Feet	50 Rounds	0 Function
Arming Test Against Vertical Armor Plate:	125 Feet	150 Rounds	150 Functions
Impact Test, 200 Meters, Against Gravel:		150 Rounds	150 Functions
Jolt:		12 Rounds	All Acceptable to MIL-STD Spec.
Jumble:		12 Rounds	All Acceptable to MIL-STD Spec.

PROOF TEST OF M550 FUZES

Tests were conducted using M550 Fuzes built on automated equipment located at Avco. Four hundred M550 Fuzes were packaged in a regular shipping container and subjected to Transportation-Vibration, MIL-STD-331, Test 114, Table I only. These fuzes were then X-rayed and built into M433 rounds using RDX short spitbacks and HE loaded cup and liner assemblies from Milan Army Ammunition Plant, Milan, Tennessee. After conditioning to proper temperature, all rounds were gun fired from an M79 grenade launcher onto the proper target.

The results of the testing are presented in the following tables:

No. Tested	Armor Target	Temperature	Range	Results		
				High Order	Low Order	Dud
50	1 inch 60°	-65	125 ft.	44	3	3
50	1 inch 60°	Ambient	125 ft.	42	5	3
50	1 inch 60°	160	125 ft.	45	3	2
50	1 inch 45°	-65	125 ft.	39	1	10
50	1 inch 45°	Ambient	125 ft.	39	3	8
50	1 inch 45°	160	125 ft.	41	3	6

No. Tested	Target	Temperature	Range	Results			
				High Order	Low Order	Dud	Richochet
46	Water	Ambient	100 meters	45	0	1	0
50	Water	160	100 meters	49	1	0	0
2	Sod	Ambient	100 meters	2	0	0	0
2	Concrete	Ambient	100 meters	2	0	0	0
50	Water	Ambient	200 meters	44	1	3	2
49	Water	160	200 meters	48	1	0	0
1	Sod	160	200 meters	1	0	0	0

Results of the testing on a target of 1-inch thick, 60° armor plate are comparable with the results of testing in October of 1973 when 100 M433 rounds were gun fired at the same target; 50 rounds with fuzes from production hardware acquired on Contract DAAA21-72-C-0852 and 50 rounds with the R&D fuze body using the three-legged actuator. The results of this testing were 5 duds for production hardware and 6 duds for the later design.

The target of 1-inch thick, 45° armor plate is comparable with gun firing test results for Functioning Reliability Impact Media conducted on Contract DAAA21-72-C-0007. It will be noted that the Functioning Reliability testing used actuators which

were not slotted. The three-legged actuator used on this last test will have the same effect if impact is made on one of the legs of the actuator. A large number of duds can be attributed to this reason; impact on one of the legs results in forcing the center-plate assembly to shift position and the firing pin misses the detonator.

A visual inspection of the duds indicated impact was, in most cases, on an actuator leg and the escapement assembly was in the full-armed position.

In regard to duds resulting from gun firing on water, no visual inspection could be made and no comparable data is available at 200 meters.

SECTION IV
DISTRIBUTION

Recipient	Copies
Commanding Officer Picatinny Arsenal Dover, New Jersey Attn: SARPA - AD-E-B-4 SARPA - QA-A-S	 3 1
Project Manager for Selected Ammunition U.S. Army Materiel Command Dover, New Jersey Attn: AMCPM-SA	 1
Defense Supply Agency DCASD, Indianapolis FCUSA, Building #1 Fort Benjamin Harrison, Indiana 46269	 2
Avco Precision Products Division Richmond, Indiana 47374	 2

APPENDIX I

OPERATION PROCEDURES

INTRODUCTION

As initially planned and set up, the automated line for assembly of the M550 PIBD Fuze consists of twelve items of equipment: two satellite assembly machines, for verge and pinion assembly, respectively; two satellite machines that work in sequence to make the centerplate assembly; and six machines, interconnected by vibratory feeder tracks, which accomplish assembly of the M550 Fuzes, less spit-back assembly; and two manually operated offline sample test machines, one for checking the escapement assembly and the other for the centerplate assembly.

The assembly sequence is shown in Figure 5. Each rectangle in the figure represents an assembly or test machine. The assembly sequence begins at the lower left, and proceeds as indicated by the arrows. The two offline sample test machines are not represented in this figure.

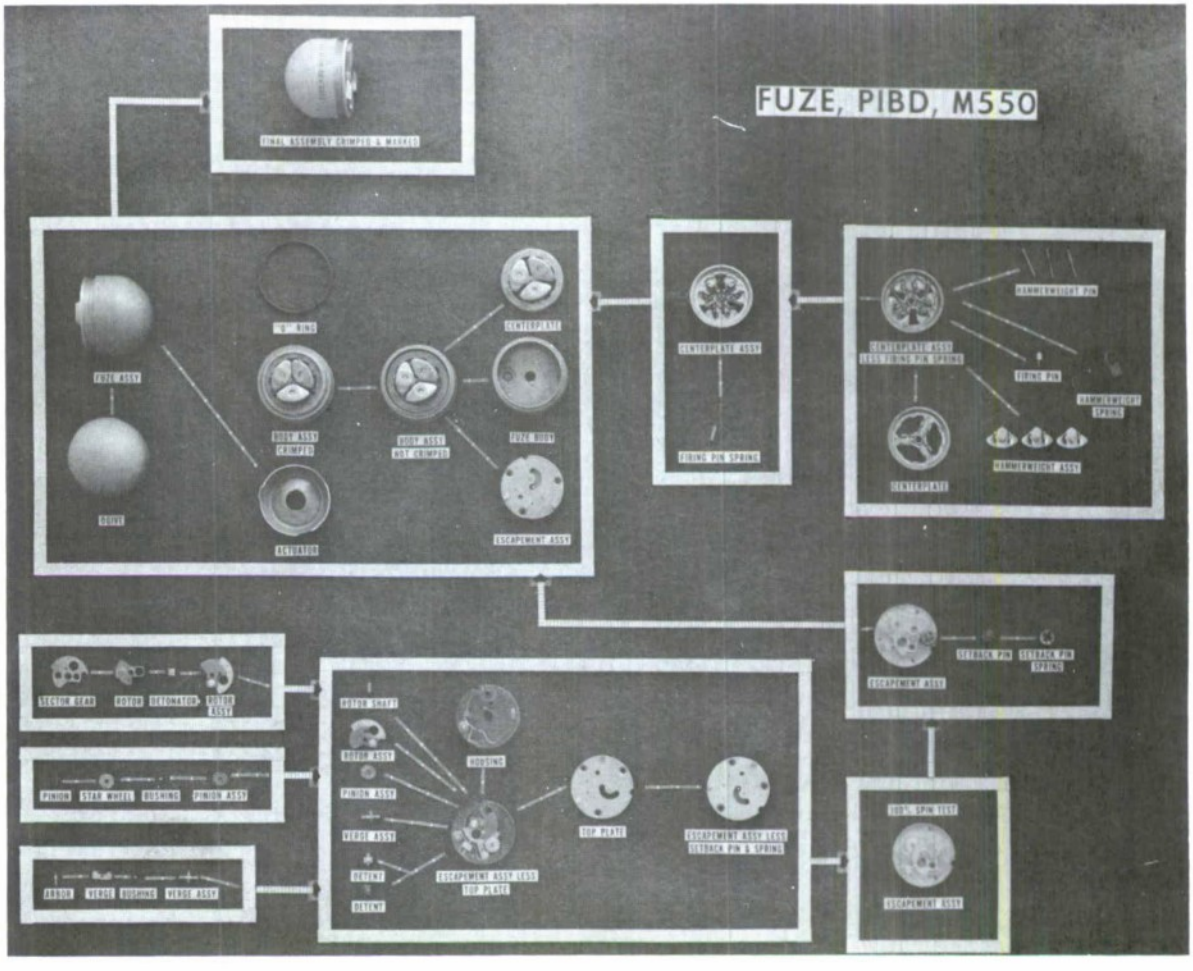


Figure 5. M550 Fuze Assembly Sequence

A description of the detailed functions of each machine by station, as of the date of this report, is given in the following paragraphs.

VERGE ASSEMBLY MACHINE

The Verge Assembly Machine was supplied by Automated Process Inc. of Milwaukee, Wisconsin. (See Figure 6.) It is a rotary type machine with sixteen stations to assemble the verge arbor, verge, and bushing. The function of each station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and place verge arbor
2.	Probe presence and position of verge arbor
3.	Orient, feed, and place verge
4.	Probe presence and location of verge
5.	Press verge onto verge arbor
6.	Idle
7.	Idle
8.	Push test 2.5 pounds to verify assembly
9.	Inspect 0.125 inch maximum dimension
10.	Orient, feed, and place bushing onto subassembly
11.	Press bushing onto verge arbor
12.	Inspect 0.175 inch maximum dimension
13.	Unload reject
14.	Probe for presence of good assembly
15.	Unload good assembly
16.	Probe for empty nest.

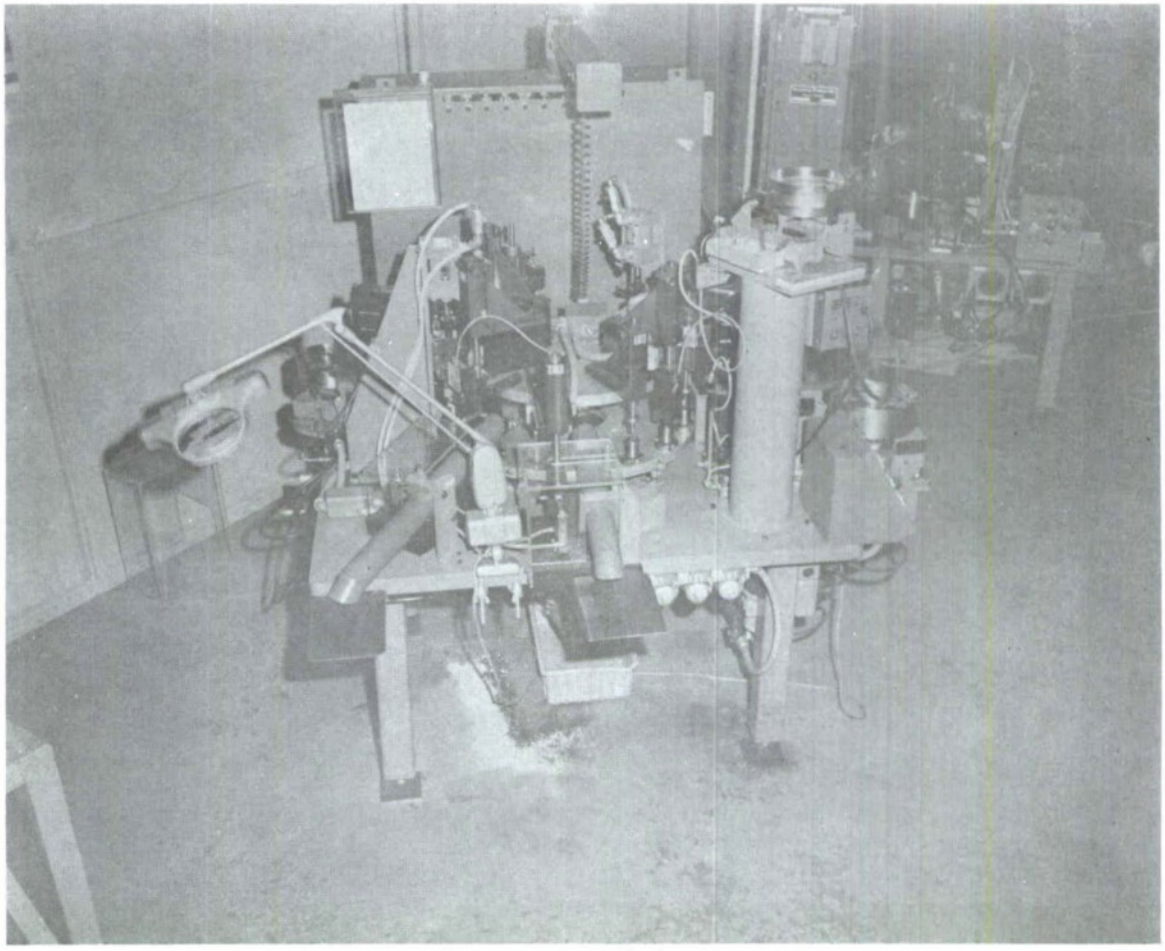


Figure 6. Verge Assembly Machine (foregound), Pinion Assembly Machine (background)

PINION ASSEMBLY MACHINE

The Pinion Assembly Machine was supplied by Automated Process Inc. of Milwaukee, Wisconsin. (Figure 6, background machine.) It is a rotary type machine with sixteen stations to assemble the pinion, starwheel, and bushing. The function of each station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and place pinion
2.	Probe presence and position of pinion
3.	Feed and place starwheel
4.	Orient starwheel
5.	Agitate starwheel
6.	Idle

STATION NO.	DESCRIPTION
7.	Probe position of starwheel
8.	Stake starwheel
9.	Verify stake with 2.5 pound load test
10.	Orient, feed, and place bushing onto arbor
11.	Press bushing onto arbor
12.	Inspect 0.175 inch maximum dimension
13.	Unload reject
14.	Probe for good assembly (automatic count)
15.	Unload good assembly
16.	Probe for empty nest.

ROTOR ASSEMBLY MACHINE

The Rotor Assembly Machine is a sixteen-station rotary type machine supplied by the Swanson-Erie Corporation of Erie, Pennsylvania (Figure 7). Its function is to stake the stamped sector gear to the sintered brass rotor, insert the M55 Detonator into the rotor, and stake it in place. Strength of each of the two stakes is checked for adequacy. The function of each station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and place sector gear
2.	Probe presence and position of sector gear
3.	Orient, feed, and place rotor
4.	Idle
5.	Stake rotor and sector gear together
6.	Pushoff test—rotor/sector gear
7.	Probe detonator hole maximum diameter
8.	Feed and place detonator
9.	Idle
10.	Idle
11.	Stake detonator

STATION NO.	DESCRIPTION
12.	Push test detonator to verify stake
13.	Unload good assembly
14.	Unload rejected assembly or parts
15.	Idle
16.	Probe for empty nest.

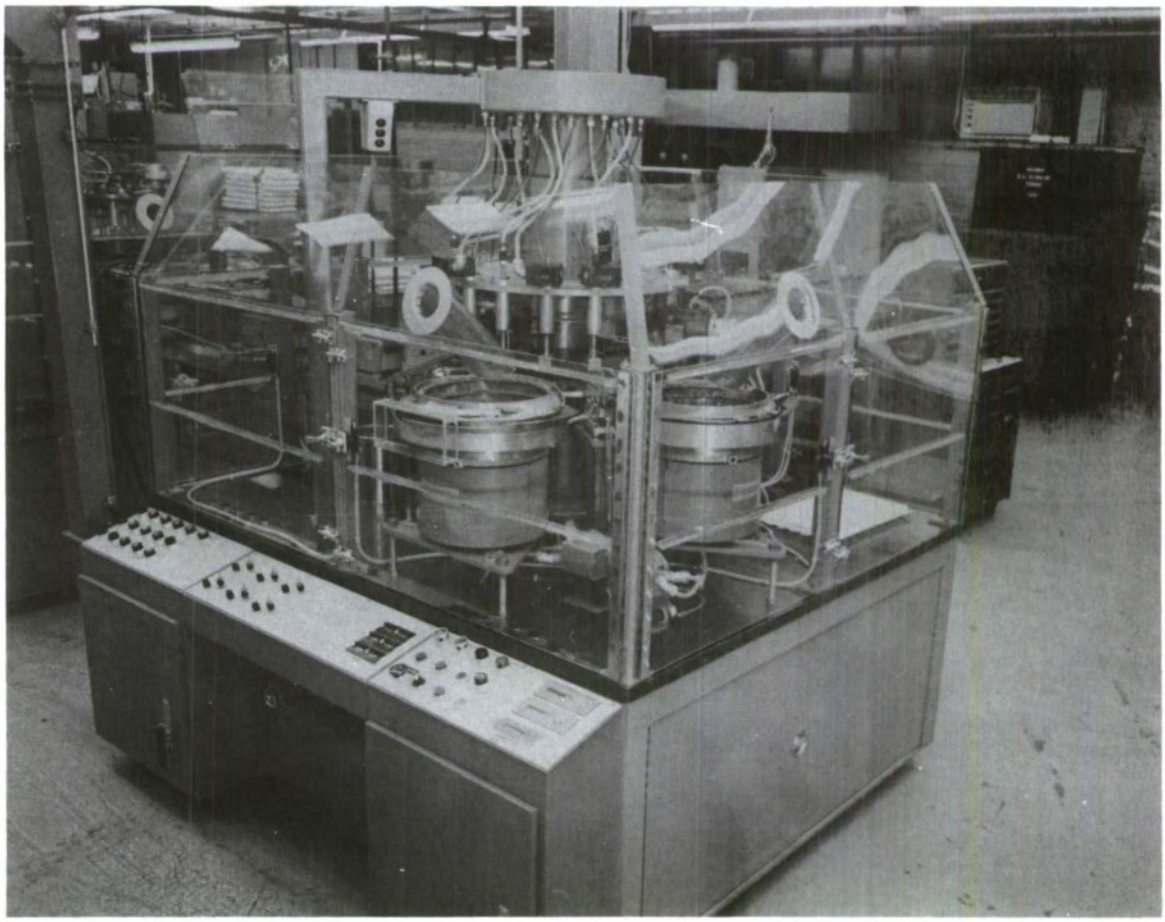


Figure 7. Rotor Assembly Machine

ESCAPEMENT ASSEMBLY MACHINE

The Escapement Assembly Machine is the most complex and sensitive assembly machine in the line, also supplied by Swanson-Erie (Figure 8). It has 20 stations in a rotary machine. Because the escapement assembly is basically a clockwork mechanism, and it provides the two independent safety mechanisms for the fuze, its proper functioning largely determines both the quality and the quantity of fuzes produced by the entire line.

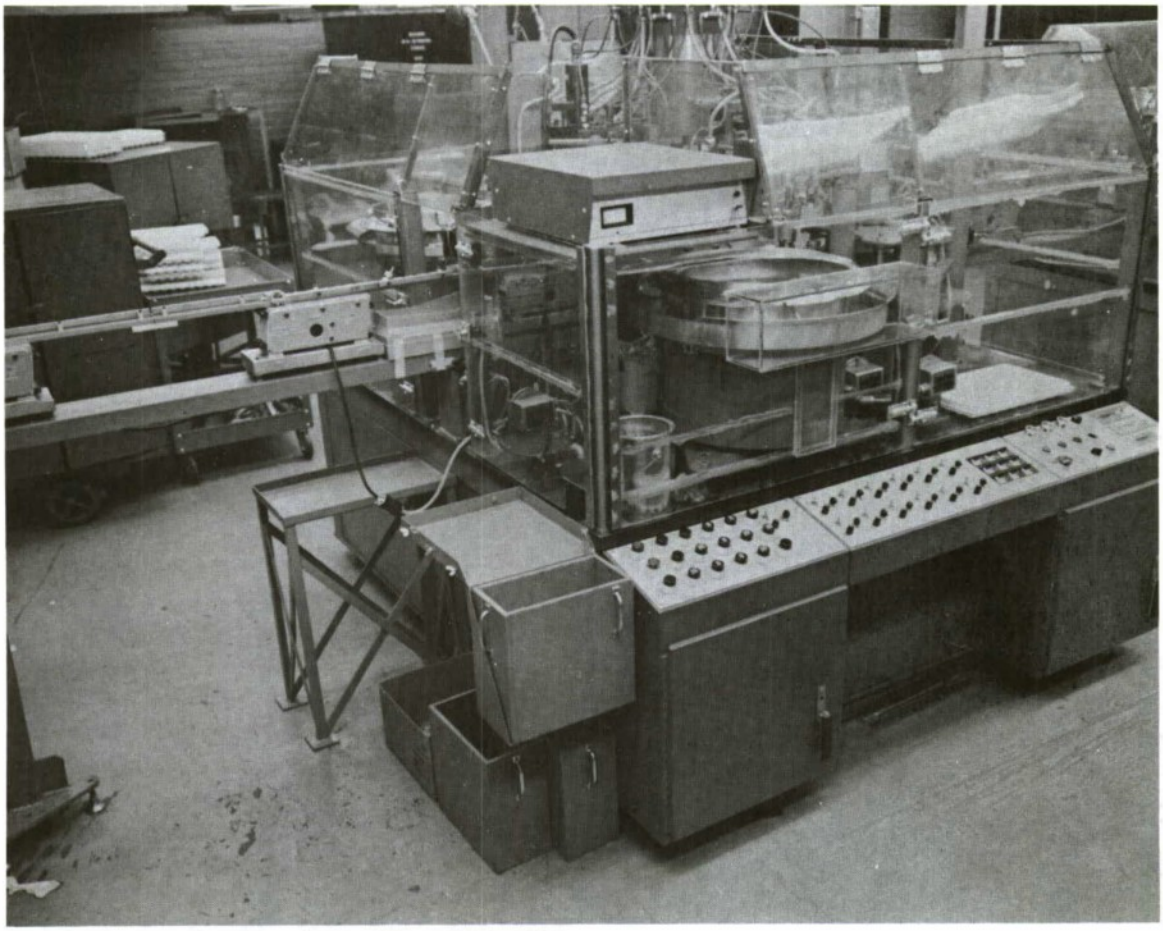


Figure 8. Escapement Assembly Machine

The assembly sequence begins by pressing the rotor shaft into the plastic (polycarbonate) escapement housing; dropping the rotor assembly over the rotor shaft; positioning of the verge and pinion assemblies so that they mesh properly with each other and the sector gear; winding the detent spring from a wire reel as required by the machine, and inserting it together with the detent into the detent cavity of the housing; placing the top plate so that it mates with the rotor shaft, verge arbor, pinion shaft, and the three protrusions of the housing, and then ultrasonically staking the housing in place.

The specific station sequence on the machine is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and place escapement housing
2.	Idle
3.	Orient, feed, and place rotor shaft
4.	Idle

STATION NO.	DESCRIPTION
5.	Orient, feed, and place rotor assembly
6.	Probe presence and location of rotor assembly
7.	Orient, feed, and place pinion assembly
8.	Probe presence and location of pinion assembly
9.	Orient, feed, and place verge assembly
10.	Probe presence and location of verge assembly
11.	Wind detent spring, orient, feed, and place detent with spring into housing
12.	Probe presence and location of detent and spring
13.	Probe for vertical orientation of verge and pinion assemblies
14.	Orient, feed, and place top plate
15.	Probe top plate for proper positioning
16.	Ultrasonically stake top plate to housing
17.	Unload good assembly
18.	Unload rejected assembly or parts
19.	Probe for empty nest
20.	Idle.

ESCAPEMENT ASSEMBLY 100 PERCENT SPIN TEST

The Escapement Assembly 100 Percent Spin Test Machine is a 20-station rotary machine supplied by the Benerson Corporation of Evansville, Indiana (Figure 9). It performs testing exclusively in which the escapement assembly is subjected to a spin rate of 3750 revolutions per minute to verify that it arms, and both a digital dial and a printed readout indicate the number of milliseconds required to arm. The assembly is resafed, and then spun at 1500 revolutions per minute, at which rate it should not arm.

In the calibration of this machine, the most important factor is that the acceptance criteria in milliseconds between the low and high values should correspond to the 45-foot no-arm and 90-foot all-arm condition when test firing the complete M433 Cartridge. Therefore a constant correlation should be maintained between the timing acceptance levels as measured by the machine and the firing test results.

Operating instructions for this machine are included as Appendix V.

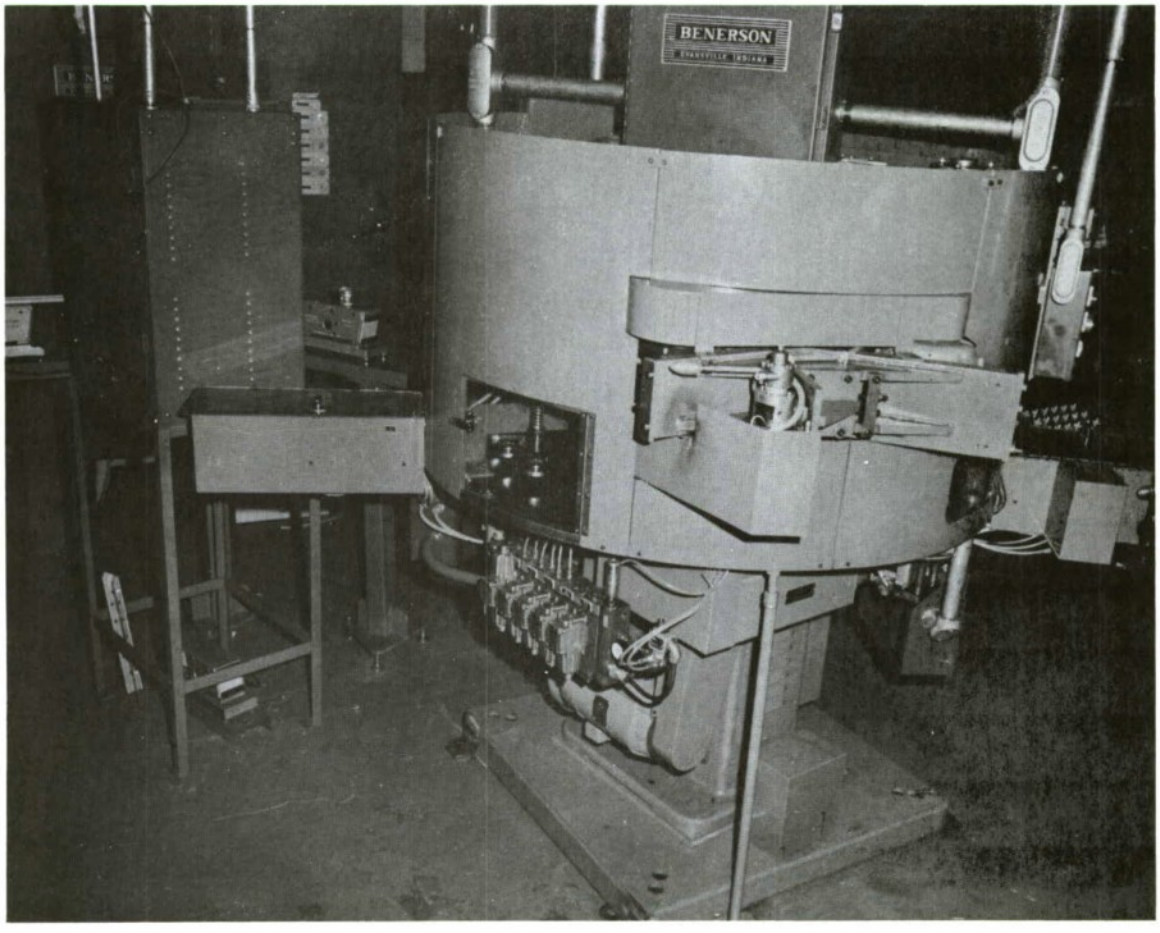


Figure 9. Escapement Assembly 100 Percent Spin Test Machine

The individual station functions for the machine is as follows:

STATION NO.	DESCRIPTION
1.	Load escapement assembly
2.	Probe for escapement and safe position of rotor
3.	Idle
4.	Spin test at 3750 revolutions per minute and check arming time
5.	Idle
6.	Orient assembly radially
7.	Probe for radial orientation
8.	Unload rejected assemblies into one of three magazines: high, low, or no-time

STATION NO.	DESCRIPTION
9.	Idle
10.	Rotate to resafe good assembly
11.	Probe for safe position of rotor
12.	Idle
13.	Spin test at 1500 revolutions per minute for no-arm
14.	Idle
15.	Orient assembly radially
16.	Probe for radial orientation
17.	Probe for safe position of rotor
18.	Idle
19.	Unload rejected assemblies into one of two magazines: resafe failure or 1500 revolutions per minute failure
20.	Idle
21.	Idle
22.	Unload good assembly
23.	Probe for empty nest
24.	Idle.

SETBACK PIN AND SPRING ASSEMBLY

The Setback Pin and Spring Assembly Machine is a 16-station rotary assembly machine supplied by the Swanson-Erie Corporation (Figure 10). Its sole function is to add the setback pin and spring to the escapement assembly. The function of each station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, place, and probe for position of escapement assembly
2.	Probe for unarmed position of rotor
3.	Orient, feed, and place setback pin, probe for setback pin
4.	Idle
5.	Orient, feed, and place setback pin spring

STATION NO.	DESCRIPTION
6.	Idle
7.	Pulloff test station
8.	Probe for presence of setback pin and spring
9.	Idle
10.	Unload good assembly
11.	Idle
12.	Unload reject assembly
13.	Idle
14.	Probe for empty nest
15.	Idle
16.	Idle.

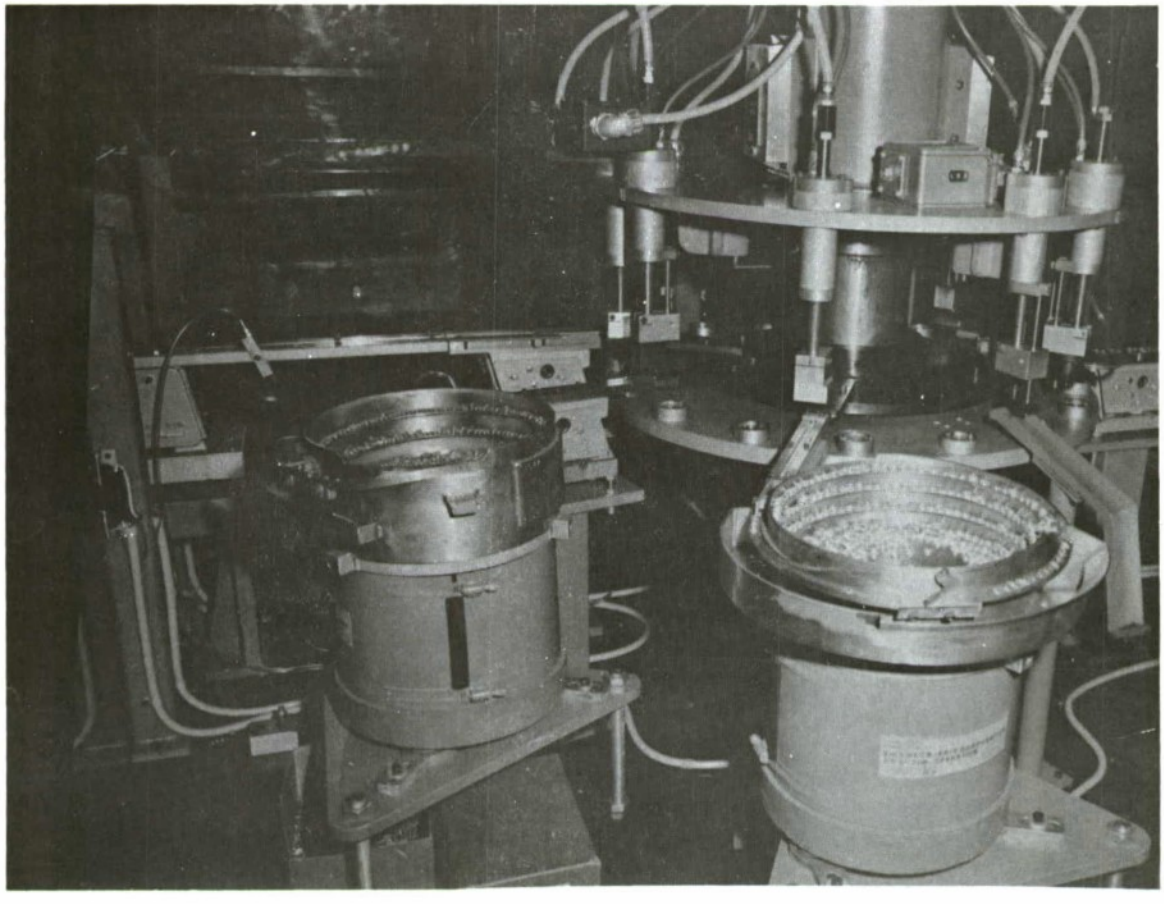


Figure 10. Setback Pin and Spring Assembly

FUZE ASSEMBLY LESS CRIMP AND MARK

The Fuze Assembly Less Crimp and Mark Machine is comparable in complexity to the Escapement Assembly Machine, and like the latter, is a 20-station rotary design supplied by the Swanson-Erie Corporation (Figure 11).

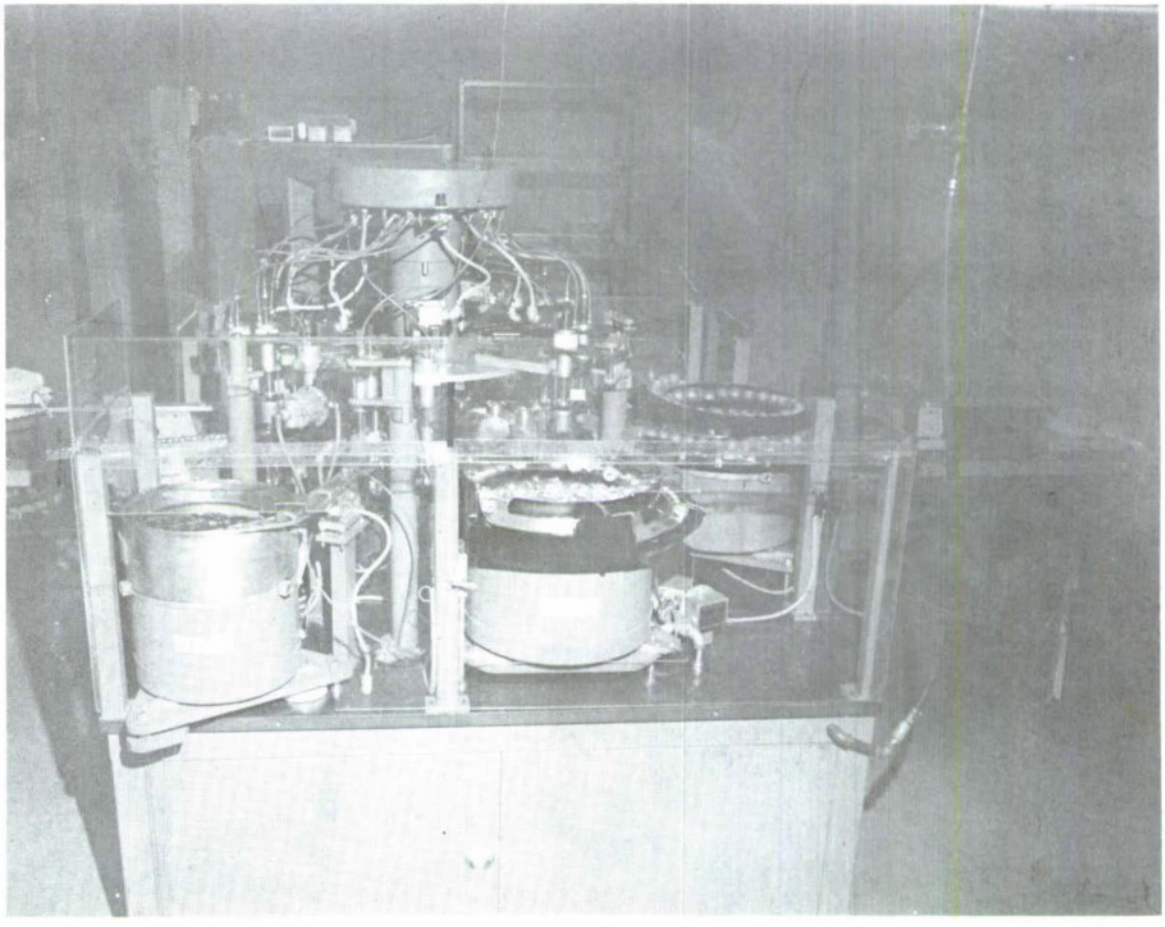


Figure 11. Fuze Assembly Less Crimp and Mark

The assembly procedure begins by orienting the aluminum fuze body in the nest, inserting the escapement assembly so that the setback pin and spring are in the cavity provided in the fuze body, positioning the centerplate assembly so that there is engagement between the two tabs on the top plate and the notches in the centerplate, and then making a complete circumferential crimp of the fuze body to keep both assemblies in proper position with respect to the fuze body and keyed to it rotationally. Next the O-ring is expanded and placed in its groove on the exterior of the fuze body, the actuator is placed in position, and the ogive is added but not crimped. The specific operations at each machine station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and load body
2.	Orient body radially in nest
3.	Probe for body orientation
4.	Idle
5.	Orient escapement assembly radially and load into fuze body
6.	Probe escapement assembly for unarmed position of rotor
7.	Orient centerplate assembly radially and load into fuze body
8.	Probe position of centerplate
9.	Crimp body
10.	Orient, feed, and place O-ring
11.	Probe for O-ring
12.	Idle
13.	Idle
14.	Orient, feed, and place actuator, and probe for its position
15.	Idle
16.	Orient, feed, and place ogive, and probe for its position
17.	Idle
18.	Unload good assembly
19.	Unload reject assembly
20.	Probe for empty nest.

FINAL ASSEMBLY CRIMP AND MARK MACHINE

The Final Assembly and Mark Machine is a 16-station rotary machine, supplied by the Swanson-Erie Corporation, that does only crimping and marking operations (Figure 12). The crimping is accomplished by a set of three contracting jaws that squeeze the ogive at the O-ring location to provide sealing as well as a

mechanical joining. The marking to identify the item and lot number is done by an offset roller printing method. Operation of each station on the machine is as follows:

STATION NO.	DESCRIPTION
1.	Load fuze assembly into nest
2.	Idle
3.	Check height of ogive and crimp
4.	Idle
5.	Idle
6.	Idle
7.	Mark ogive
8.	Idle
9.	Unload all assemblies
10.	Idle
11.	Idle
12.	Idle
13.	Probe for empty nest
14.	Idle
15.	Idle
16.	Idle.

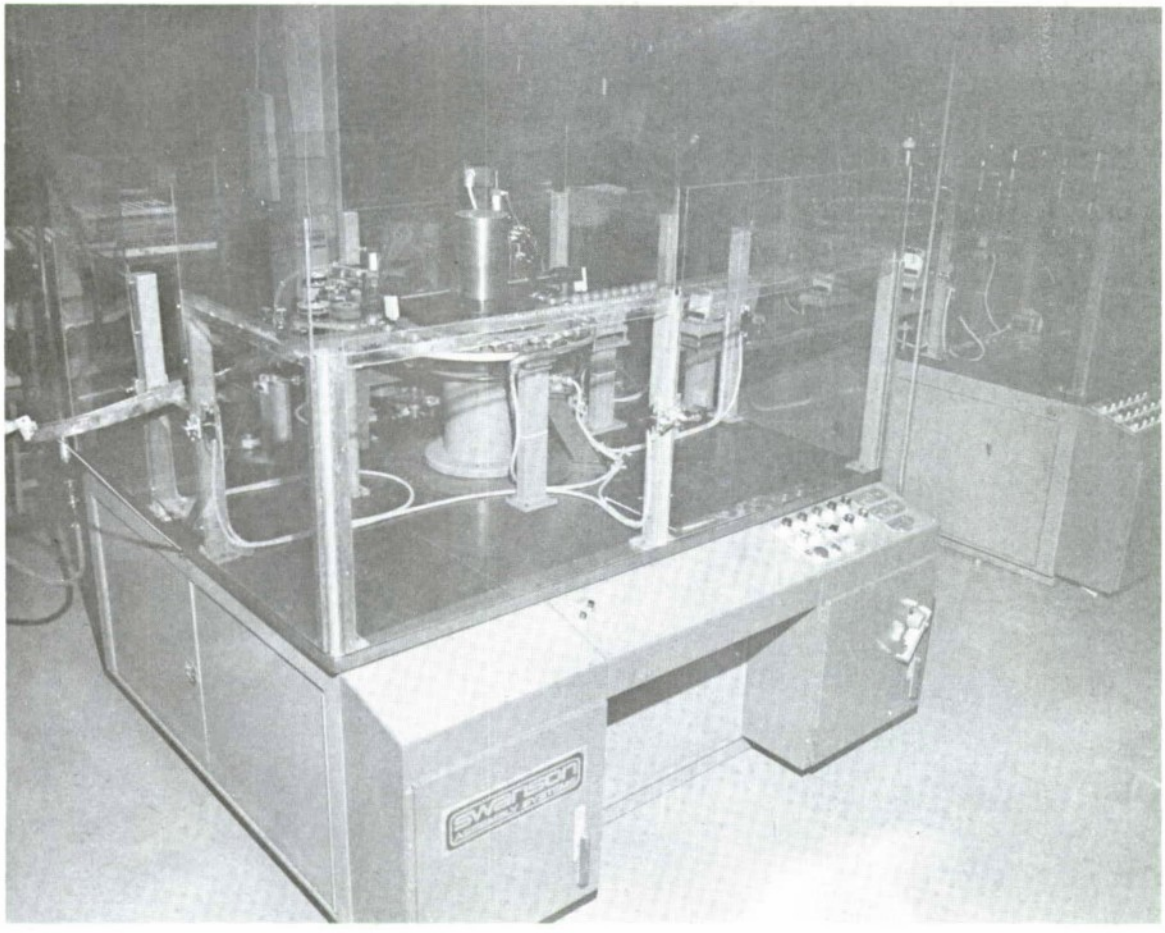


Figure 12. Fuze Crimp and Mark Machine

CENTERPLATE ASSEMBLY MACHINES

Two Centerplate Assembly machines operate in sequence to make the centerplate assembly (Figures 13 and 14). They were originally designed and built by the Honeywell Corporation about 1964, and were supplied to Avco as Government Furnished Equipment rather than buy a new machine to perform this assembly. It was known that the normal capacity of these GFE machines is only about 750 to 800 assemblies per hour, thus making the entire fuze assembly line unbalanced. The plan was to supply the Honeywell machines well in advance of the new equipment, and build up a bank of centerplate assemblies some months before the rest of the line could be in operation. In this manner it was expected that the first production contract for 1.5 million M550 Fuzes could be produced with an unbalanced line.

The first of these machines is a rotary type with 16 stations. The greatest single difference between it and the new machine is that on the earlier Honeywell machine the entire machine stops each time there is a fault sensed at any one station. It is necessary for the operator to identify from the light signal which station has the fault, clear the trouble, possibly insert another part manually, and then push the reset button before machine cycling resumes. While this is being done, several machine cycles are lost, resulting in reduced output per hour.

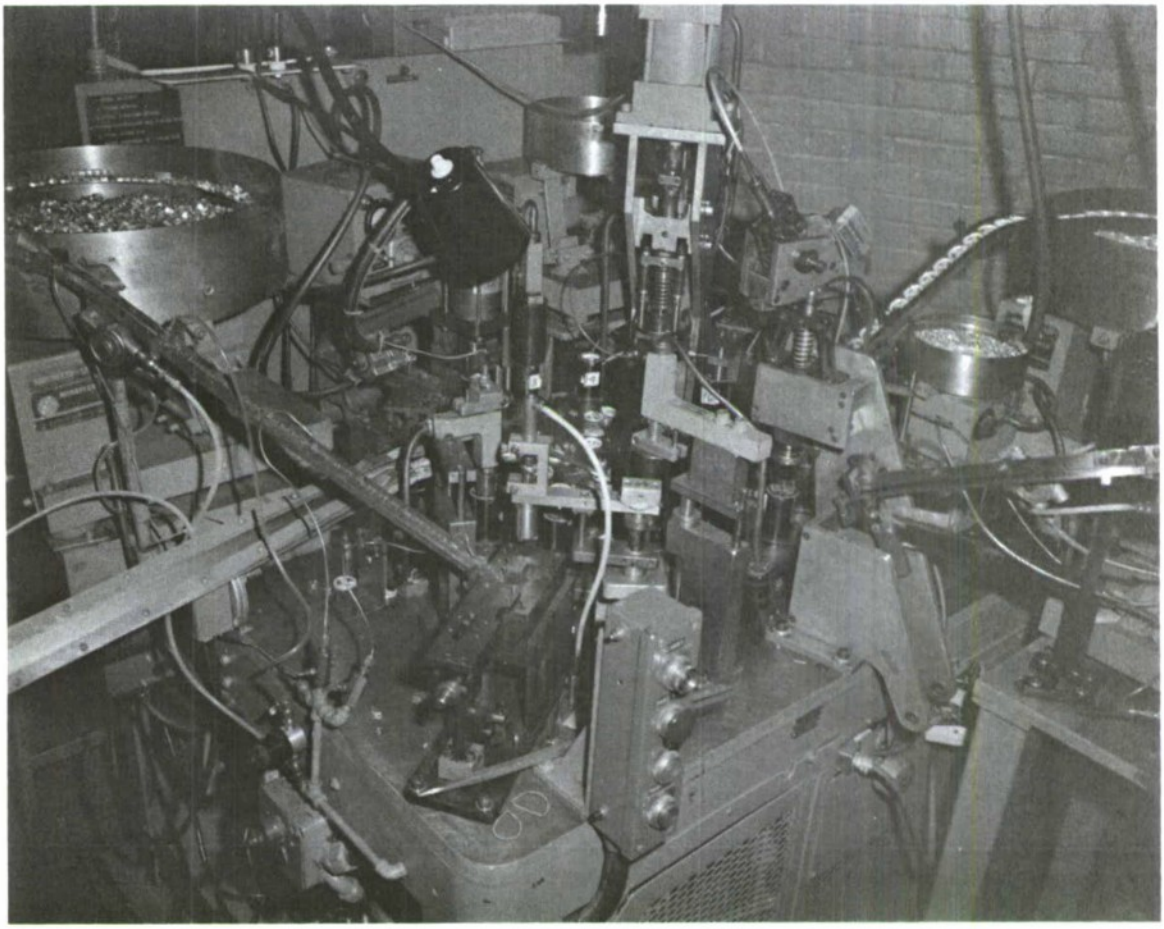


Figure 13. Centerplate Assembly Machine Less Firing Pin

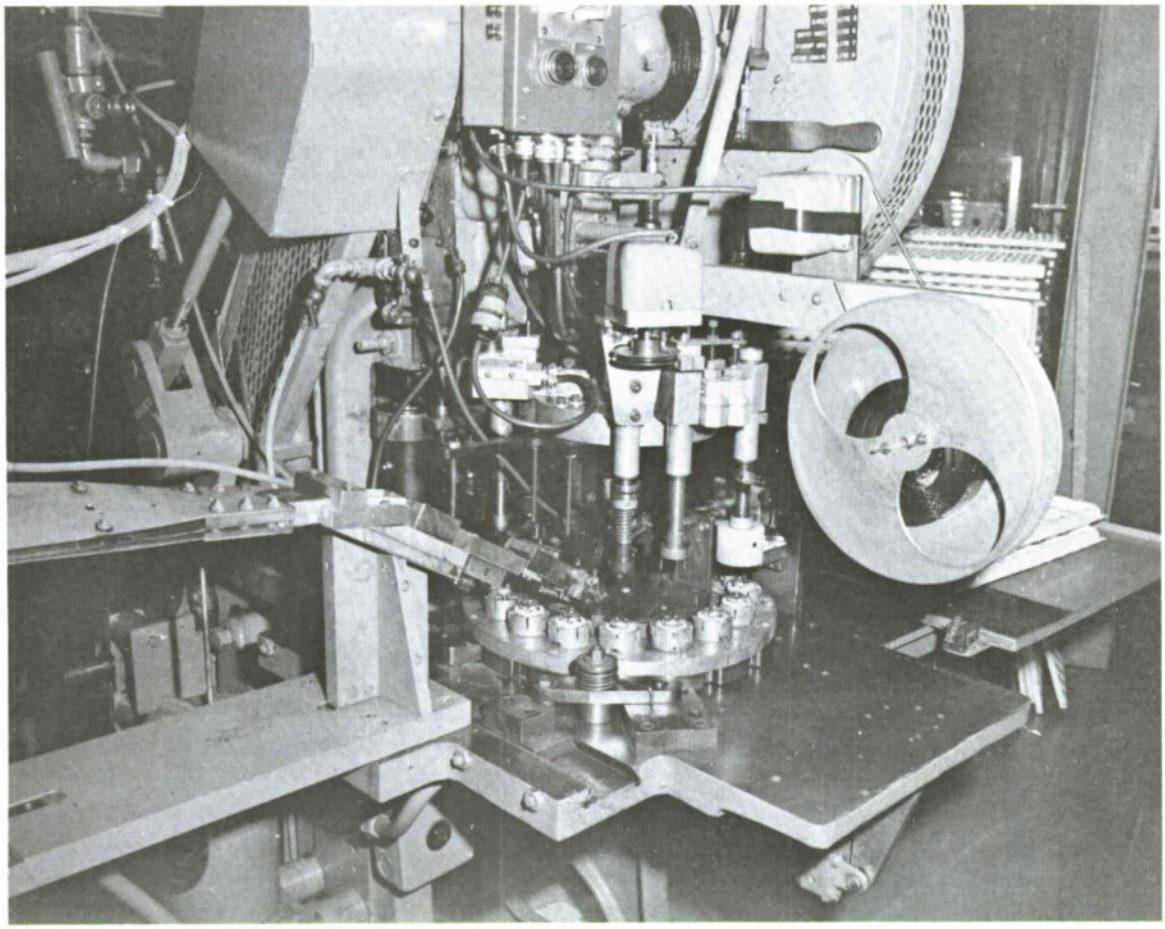


Figure 14. Firing Pin Assembly to Centerplate Machine

By comparison, each of the new machines has the addition of built-in logic circuitry, so that if a fault is sensed at a particular station, the machine continues cycling, but no further assembly operations are performed on that station, and parts or an improper assembly is then automatically ejected at the reject station. In most cases, three consecutive faults must be sensed at the same station before machine cycling stops. This greatly increases the actual machine cycles per hour and thus improves the yield.

The function performed at each station is as follows:

STATION NO.	DESCRIPTION
1.	Orient, feed, and place three hammerweight assemblies
2.	Probe for hammerweights
3.	Idle
4.	Orient, feed, and place hammerweight spring

STATION NO.	DESCRIPTION
5.	Idle
6.	Probe for hammerweight spring
7.	Assemble firing pin to centerplate, place centerplate in nest
8.	Probe for centerplate and firing pin
9.	Orient, feed, and place three hammerweight pins
10.	Idle
11.	Probe for three hammerweight pins
12.	Stake centerplate to hold hammerweight pins
13.	Idle
14.	Idle
15.	Unload assembly
16.	Probe for empty nest.

The second machine of this pair is a modified punch press that performs two functions:

1. The firing pin spring material is purchased in coils, being in the form of preperforated flat stock. In the press operation, the final forming is accomplished and the spring is separated from the strip.

2. The completely formed spring is then placed onto the firing pin so that the three inward-pointing tangs engage in a circumferential groove, thus completing the centerplate assembly.

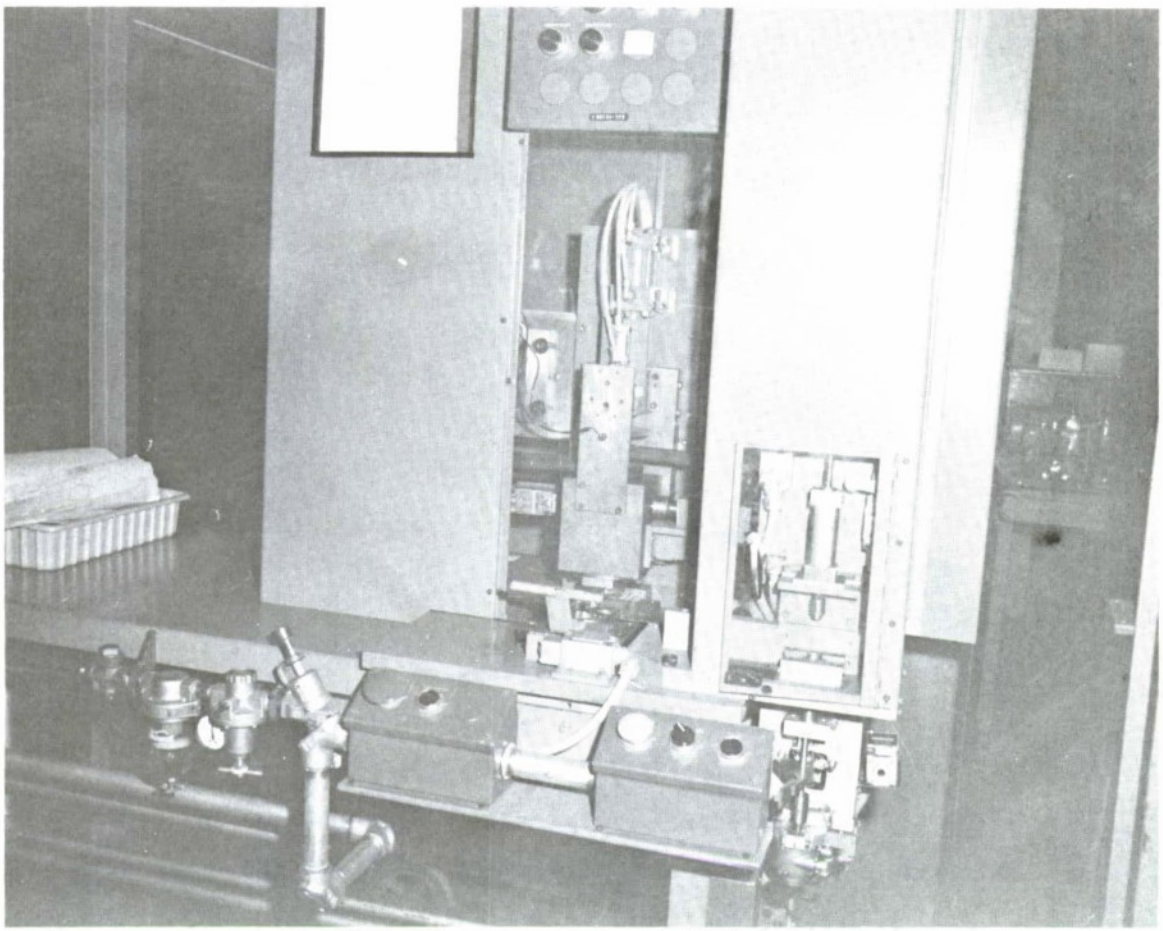


Figure 15. M550 Fuze Escapement Assembly Sample Test Machine

CENTERPLATE ASSEMBLY SAMPLE TEST

The Centerplate Assembly Sample Test Machine is an offline machine, used on a sample basis for manually verifying quality of the centerplate assemblies produced on the two items of Government Furnished Equipment (Figure 16).

The criteria against which each assembly is checked are as follows:

The firing pin must move 0.020 inch minimum at 3000 -50 revolutions per minute under a 30± 1 gram load, and may move 0.020 inch maximum at 1000 + 25 revolutions per minute under a 30± 1 gram load.

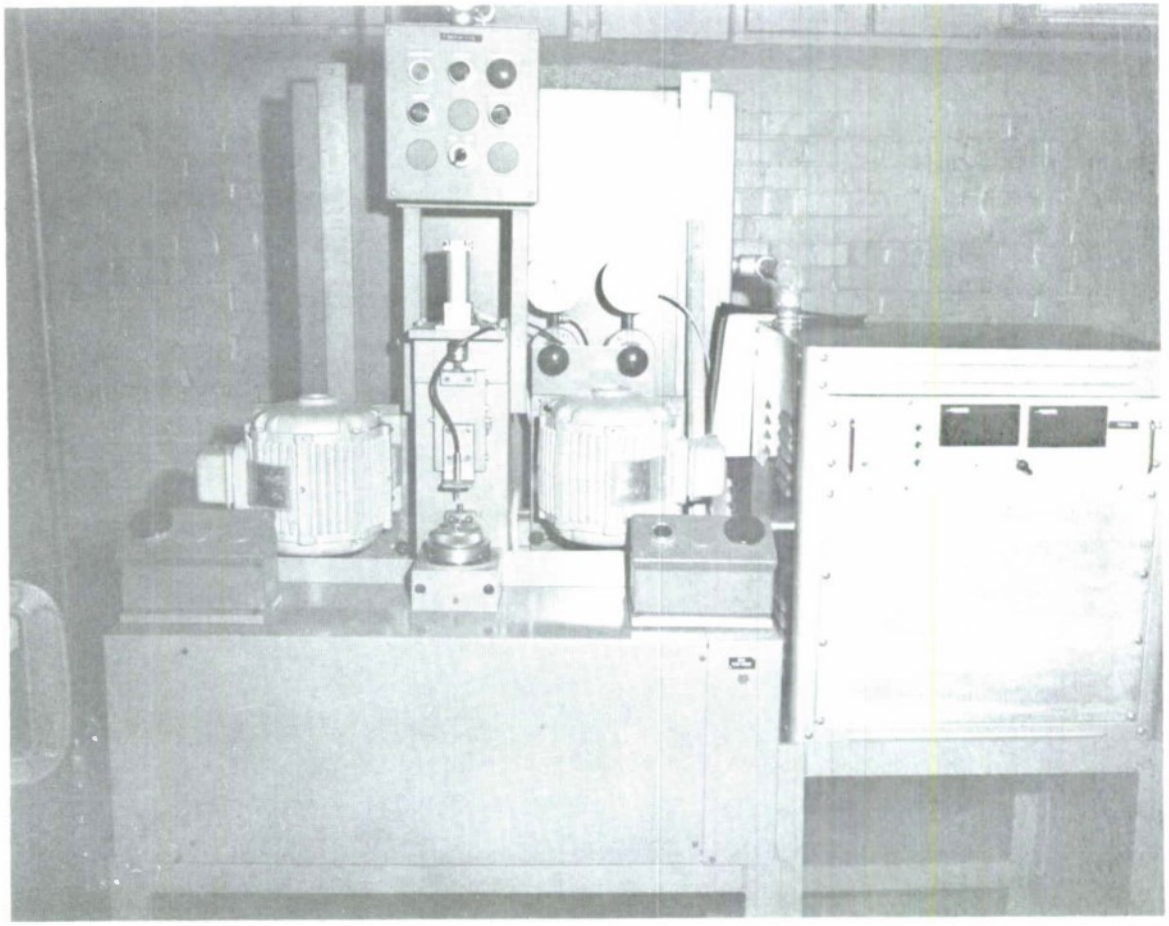


Figure 16. M550 Fuze Centerplate Assembly Sample Test Machine

APPENDIX II
SAMPLE PURCHASE DESCRIPTION FOR EQUIPMENT (PDE) FOR CENTERPLATE ASSEMBLY MACHINE

PDE IX
Amendment #3

AVCO PRECISION PRODUCTS DIVISION

AUTOMATIC ASSEMBLY MACHINE

CENTERPLATE ASSEMBLY 198714

25 OCTOBER 1973

PDE IX, Amendment #3

Date 25 October 1973

AVCO PRECISION PRODUCTS DIVISION
PURCHASE DESCRIPTION
AUTOMATIC ASSEMBLY MACHINE
TO ASSEMBLE M550 CENTERPLATE
ASSEMBLIES 198714

General Description

This purchase description (PDE IX, Amendment #3) is for the purchase of an automatic machine which will completely assemble the M550 Centerplate Assembly.

This machine will have the long-range production capability to produce assemblies for a minimum of five years with reasonable maintenance.

The machine cycle shall be designed for 2,400 gross production rate with an optimum running rate of 2,100 per hour. This machine will be equipped with variable drive.

Net machine output must produce a minimum of 1,730 acceptable centerplate assemblies per hour. Acceptable assemblies are units which comply with the attached Inspection Procedure, Appendix No. 1.

The machine reject rate, excluding defective detail parts, must not exceed 103 pieces per hour and must not reduce the minimum net production rate.

The above quantities are based on good quality parts being supplied by Avco. If bad parts cause multiple rejects, this downtime cannot be counted against the machine.

This machine must have the capability to orient, load, assemble, inspect (as required), and accept or reject M550 Centerplate Assemblies without distorting or mutilating the component parts.

The following requirements shall be met to give Aveo Precision Products Division a long-range production capability.

General Design

1. A maximum of one operator shall be utilized to operate this machine with no more than normal effort.

2. The machine will automatically feed and properly assemble all components in the M550 Centerplate Assembly.

3. The design of the machine is to be such that the specified net hourly output will be maintained even though detail parts may vary within the tolerances of the drawings. A burr on the parts within the tolerance of the drawing is not to hamper the performance of the machine.

4. Design method of feeding all details in oriented position at a faster rate than the maximum machine cycle time.

5. After placement of a given part, a probe will check presence and orientation of this given part.

General Design (Continued)

6. A fault light is to be provided, which can be viewed 360°, which will indicate (by number) the station which has caused the machine to stop. Each probe is to have a light. Convenient reset buttons are a requirement.

7. The Memory System on this machine shall be such as to control the operational assembly sequence of this PDE. The control of this memory shall be via mechanical pins or shift register, whichever is more feasible.

8. The transfer mechanism will be of suitable design to transfer parts as required. The drive unit must allow smooth acceleration and deceleration of index, with an automatic disengagement and signal device when overload or bind occurs, as well as manual disengagement with a jog button to facilitate hand operation.

9. Master setblock will be provided for selected working stations to enable accurate setting and checking of the tooling with a minimum of effort; Avco's Quality Control Department is to select stations. All setblocks will be identified and permanently marked.

10. Provide safety switch to stop machine when air pressure falls below preset level.

11. Provide feeder track from unload (accepted assemblies) station to final fuze assembly machine. Present track may be modified. Layout of machines and area to be provided by Avco.

General Design (Continued)

12. Design feed track for selection and re-insertation to line of inspection samples for a continuous sampling plan upon demand. Frequency is to be selectable for one assembly per 50, 100 or 200 assemblies. Make so Inspector can take out piece at any time and re-insert part at any time.

13. Protect all non-working surfaces to prevent corrosion. Surfaces not painted may be coated with permanent type rust inhibitor. Protect all working surfaces to prevent deterioration.

14. Components using air to actuate any motion of this machine should be engineered to have capacity to supply more than the anticipated needed power, and meet OSHA requirements.

15. The machine will have three (3) counters. Two (2) counters will register "accepted assemblies" and "rejected assemblies" and will be key resettable. The third counter will register total machine cycles and will be non-resettable.

16. The machine will have a triple fault memory system. A negative signal at the probe stations for: Hammerweight Assemblies, Hammerweight Spring, Firing Pin, Centerplate, Hammerweight Pins and Firing Pin Spring will allow the machine to continue operating, but lock out subsequent operations and result in rejecting the faulty assembly at the reject station. Three consecutive negative probes at a single station

General Design (Continued)

will stop the machine with tooling retracted just prior to index. A memory system which provides for variable setting of consecutive faults before machine stoppage is acceptable and desirable.

A negative probe at the station probing for an empty nest, or an empty magazine signal at the Firing Pin Spring and Hammerweight Spring loading station, will light an indicator on the control panel and stop the machine with tooling retracted just prior to index.

Reproducible drawings must be provided at the time equipment is delivered on all recommended spare parts and perishable tools.

OSHA Compliance

Machine builder must comply with Federal Occupational Safety and Health Act of 1970 - Public Law No. 91-596. Vendor to submit detailed plans of compliance to Avco for approval prior to total design approval.

Construction

1. All mechanisms shall be simple, rugged, adjustable and standard where possible. Any parts subject to wear must be replaceable and dimensioned so they are interchangeable with a minimum amount of downtime.

Construction (Continued)

2. All feeder bowls, where required, are to be lined with a suitable material inside and out. They shall also be equipped with a source or flow control, to be decided upon by manufacturer, which will cause the bowl to operate or feed only when parts are needed. All feeder bowl bases shall have an adjustable sub-base for leveling the height adjustment.

3. All moving parts are to be easily accessible for maintenance, replacement, adjustment, and lubrication when required.

4. All gaging probes, punches, nests and chutes shall be constructed to prevent damage to the component parts and the finished assembly.

5. The machine shall be sturdily constructed, and sufficiently braced to withstand maximum loads. The machine size shall take a minimum amount of floor space and be free standing with no additional supports to the floor other than machine base.

6. All feed mechanisms to be constructed to prevent damage to component parts. Materials used are to be wear resistant to give efficient long life.

7. The machine construction will be compact, uncluttered, and rugged.

8. All work stations shall be self-contained units with adequate enclosures, removable, if necessary, to prevent foreign material from getting into functional mechanisms.

Construction (Continued)

9. All pivot points to be supported by anti-friction bearings for accuracy, rigidity, and long life.

10. Where possible, mechanical motion drives and mechanical means will be used to facilitate feeding of assembly components rather than air. If air is considered, Avco is to be contacted and a review conducted. Final prints must highlight where air is considered.

11. All electrical controls shall be on readily accessible panels, plainly labeled, with adequate and strategically placed emergency-stop controls, such as trolley cord.

12. Air and electrical switches to be cam operated.

13. Central lubricating system of sufficient capacity to provide adequate lubrication of all functional members of the basic machine and all tooling to give long life with minimal wear.

14. Shot pins, or lock blocks, must be utilized where necessary at working stations in order to insure repeated accuracy.

Guarding

All equipment and attachments shall be guarded to provide protection to operators, equipment, and accessories. (Guarding must comply with Federal Occupational Safety &

Guarding (Continued)

Health Act of 1970 - Public Law No. 91-596 and be approved by Avco Precision Products Division.) This should be part of drawings called for on page #9 under OSHA.

Painting

All exterior structure and sheet metal surfaces shall be given a minimum of one coat of primer and two coats of Pittsburgh Paint Company #23-76. Vista Green Lavax Machinery Enamel. Electric boxes and similar accessories are to be painted in accordance with OSHA Requirements.

Electrical and Air Requirements

1. Power shall be supplied by electric motor and/or hydraulic power and/or compressed air, whichever best suits the manufacturer's design and either/or all of sufficient capacity to satisfactorily propel all units and auxiliary apparatus under maximum loads.

2. Electrical motors and starters shall be for use with 220/440 V.A.C. wired 440 volts, three (3) phase, sixty (60) cycles, with auxiliary electrical equipment, and 1/3 H.P. motors or less may be 110/220 V.A.C. single (1) phase, sixty (60) cycles. Step down transformers to be part of equipment supplied and wired in by vendor. Electric motors, switches, wiring and solenoids must meet NEMA standards.

3. All hand operated switches to be maximum 110 volts A.C.

Electrical and Air Requirements (Continued)

4. Two (2) 110-volt A.C. outlets are to be supplied on the machine, one on each side

5. Electric motors, switches, wiring, fixtures, fittings, instruments, mechanisms, and accessories must be Underwriter approved or must have the approval and certification of another acceptable testing laboratory.

6. Main control panel to have start, run, jog and stop switches and capacity and spare wire (labeled) for 15% future additions.

7. Electric solenoids to be Numatics or Bellows-Valvair, or equivalent.

8. Compressed air is available at a line pressure of eighty (80) pounds minimum per square inch. When using air, a surge tank is to be provided, if required, for efficient machine operation.

9. Air regulators, filters, and dryers to be Norgren or Schrader heavy-duty or equivalent approved by Avco Precision Products Division.

Approval and Acceptance

1. The design of this unit, including OSHA requirements, shall be approved in concept by Avco Precision Products Division before proceeding with its manufacture. The above approval shall not be construed as a check but as an indication that the general design is satisfactory and compatible with Avco Precision Products Division engineering principles.

Approval and Acceptance (Continued)

2. Proofing and debugging shall be accomplished at the manufacturer's facility with shipping acceptance subject to a satisfactory continuous run of 5,000 parts as per specifications and rates in General Description and witnessed by Avco Precision Products Division representatives.

3. Final acceptance of the machine will be at Avco Precision Products Division at Richmond, Indiana. Approval for final acceptance will be made after the machine has successfully completed four (4) hours of continuous run at or above the specified net production rate, utilizing only one man for the sustaining operation.

4. A complete set of reproducible, working drawings, diagrams of all systems (air, electrical, hydraulic), three (3) complete lists of spare parts, and three (3) manuals containing maintenance, operation, set up and trouble shooting instructions in conformance to Avco Precision Products Division requirements will be included. (These manuals, drawings, instructions, etc. shall be written in English, and sent to Avco Purchasing Department.)

5. Service personnel will be supplied for a period of five (5) days free time to supervise the training of operating personnel. Schematics, operator training, and maintenance instruction manuals must be provided five (5) days after the machine acceptance run at vendor's plant.

   Avco has option to send an Engineer in to vendor's plant once assembly operation has started and stay with machine until complete.

Approval and Acceptance (Continued)

6. Avco Precision Products Division Engineers reserve the right to check on the progress of machine design and fabrication any time prior to shipping.

7. The equipment vendor will, in writing, provide to Avco within ten (10) days after receipt of Aveo furnished piece parts any complaints on quality. Avco must send inspection reports with parts.

Aveo Preeision Products Division Responsibility

1. Aveo Precision Products Division Engineering will furnish sketehes as guidelines for methods and sequences of assembly.

2. Signed approvals of machine layouts at the times specified by the manufacturer.

3. Unload machine at Aveo Precision Products Division and move to proper designated location.

4. Installation of the machine, per approved layout, including necessary air supply line and electrical feeders to the machine.

5. 16,025 jobs of detail parts of certified quality for debug and trial run.

6. Conneetions to air and eleetrical control boxes.

7. Inspection procedures and piece part drawings will be furnished.

General Notes

1. A 1/4 inch per foot floor plan layout of the tooled machine will be sent to Avco Precision Products Division Purchasing Department upon approval of final design.

2. Allowance is to be made for idle stations, where needed, to facilitate access for set up or repair.

3. Progress reports will be supplied to Avco Precision Products Division Purchasing Department on the 15th of each month covering status of both equipment and funding per sample attached.

4. Lubricating instructions and recommended types of lubricants are to be included in the maintenance manual.

5. Schematics must be approved same time mechanical drawings are approved.

6. Manuals must have detailed instructions on stations that require adjustments.

Machine Description

An automatic machine to assemble Centerplate Assembly, Part Number 198714, utilizing a Swanson-Erie Chassis Model 20-GS-33 (Ose. Ring) System.

612-D

INSPECTION PROCEDURE

PROD. NO. 8485 8484 SPEC. PARA. NO. 4.3.3.9 4.3.3.10 (1)(2)(3)

AVCO P/N 105714 REV. F NAME Centerplate Assy. AVCO NO.

INSP. OPER. NO. DEPT. OPERATION Static Lot Inspection

LOT SIZE MIN.

PROCEDURE REV. NO. 5 AND EFFECT. DATE 8-29-75

A.Q.L. MAJOR - MINOR 0.65 UNCLASSIFIED ~~1.00~~ 0.65

APPROVALS	DATE
Q. C.	
Reviewed by: QAR:	
Prepared By: P. R. Sherman	12-5-7

C/D NO.	DESCRIPTION OF QUALITY CHARACTERISTIC	AMMISSION	GAGE NO.	CODE NO.	REMARKS
201 501	Evidence of poor workmanship including excessive ~~[illegible]~~	-	Visual		Sample inspect per MIL-ST 105D unless otherwise specified. Optional to use an approv continuous sampling plan in accordance with MIL-ST 1235 for this assembly.
~~502~~ 502	Crimp improper (6 places)	0/Note 2	Visual		
	SPECIAL TESTS				
"A"	Arming of Centerplate Assembly	.060 min. 1/Note 4			
	One-hundred and twenty-five (125) centerplate assemblies shall be				
	selected from each lot and subjected to this test. If two (2) or				
	more assemblies fail to comply with drawing requirement, the lot				
	shall be rejected.				
"B"	Retention check of firing pin spring on				
	centerplate assembly	0/Note 5	105714-TT3-A		

1. The Critical 1, 2, 3 etc., Majors 101, 102, 103 etc., Minors 201, 202, 203 and other requirements are requirements of the Purchase Description.
2. The 501, 502, 503 etc., are characteristics not classified by Ordnance.
3. Dim. if reference only. This Procedure to be used with latest applicable Dwgs. P.O's or Oper. Sheets. NOTE: All changes, Rev's. or Dev's. from this Procedure must be approved by the Quality Engrg. Dept.

REF: MIL-P-50869A(MU) PROCEDURE

REV. AMEND. ISSUE NO. 1 DATE 12-5-75 PAGE NO. 43 OF 91

612-D

INSPECTION PROCEDURE

PROD. NO. 8485 8484 SPEC. PARA. NO. 4.3.3.13

AVCO P/N 198714 REV. F (12) (3) NAME Centerplate Assy AVCO NO.

INSP. OPER. NO. DEPT. OPERATION Static Lot Inspection

LOT SIZE MIN.

PROCEDURE REV. NO. 3 AND EFFECT. DATE 8-29-73

A.Q.L. MAJOR - MINOR 0.65 UNCLASSIFIED ~~0.65~~

APPROVALS	DATE
Q. C.	
Reviewed by: QAR:	
Prepared By: P. R. Sherman	12-5-7

C/D NO.	DESCRIPTION OF QUALITY CHARACTERISTIC	DIMENSION	GAGE NO.	CODE NO.	REMARKS
"B" Cont	After completion of Test "A", the forty-two (42) centerplate assemblies shall				
	be subjected to this test. If two (2) or more assemblies fail to comply with				
	the drawing requirement, the lot shall be rejected.				
"C" (3)	Separation test of hammerweight pin on centerplate				
	assembly	5 lb. P/Note 3	198714-TP-2-A		
	forty-two (42) centerplate assemblies shall be selected from each lot and the				
	hammerweight pins on each of the three legs of each assembly shall be subjected				
	to this test. If two or more centerplate assemblies fail to comply with the requirement				
	specified on the applicable drawing, the lot shall be rejected.				
"D"	Push-out on hammerweight assembly on centerplate				
	assembly				

1. The Certificate of Conformance, Paragraphs 101, 102, [illegible] and other requirements of the Purchase Description.
2. The 501, 502, 503 etc., are characteristics not classified by Order [illegible].
3. Dim. [illegible] reference only. This Procedure to be used with latest applicable Dwgs. [illegible] Notes, etc. changes, Revis. or Revis. [illegible] from this Procedure must be approved by the [illegible]

REF: PROCEDURE
REV. AMEND. ISSUE NO. 1 DATE 12-5-73 BY

R-312-4

INSPECTION PROCEDURE

PROD. NO. 8485 S434 SPEC. PARA. NO. 4.3.3.12 (2.3)

AVCO P/N 198714 REV. F NAME Centerplate Assy. ORD. NO.

INSP. OPER. NO. DEPT. OPERATION Static Lot Inspection

LOT SIZE MIN.

PROCEDURE REV. NO. 1 AND EFFECT. DATE 9-24-71

A.I.L. MAJOR - MINOR 4.0% UNCLASSIFIED 1.0% 0.4%

APPROVALS	DATE
Q. C.	
Reviewed by: QAR:	
Prepared By: P. R. Sherman	12-5-72

[illegible]	DESCRIPTION OF QUALITY CHARACTERISTIC	DIMENSION	GAGE NO.	CODE NO.	REMARKS
[illegible]	Forty-two (42) centerplate assemblies shall be [illegible] from the lot and				
	the hanger eight use by on each of the th[illegible] [illegible] shall				
	be subjected to this test. If two (2) or more [illegible] fail				
	to comply with the requirement specified with[illegible] the lot				
	shall be rejected.				
	NOTE: Perform t[illegible] in sequence given the test "W" is a destructive test.				
	Parts so tested shall not be returned to the lot.				

1. The Critical 1, 2, 3 etc., Majors 101, 102, 103 etc., Minors 201, 202, 203 and other requirements are requirements of the Purchase Description.
2. The 501, 502, 503 etc., are characteristics not classified by Ordnance.
3. Dim. if reference only. This Procedure to be used with latest applicable Dwgs. P.O's or Oper. Sheets.
   NOTE: All changes, Revis. or Deviations from this Procedure must be approved by the Quality Engrg. Dept.

REF: PROCEDURE
REV. AMEND. ISSUE NO. 1 DATE 12-5-72 PAGE NO. 65 OF 91

DATE: 5 June 1973

CONTINUOUS SAMPLING PLAN

CSP-1 - LEVEL II

M550 FUZE

I. In order to qualify for Continuous Sampling, a process should have the following characteristics:

(a) Moving Product: i.e. the product should move continuously along a conveyor belt, or on a carrier that is moving at a consistent rate of speed.

(b) Facilitate 100% Inspection: The product should be one which can be 100% inspected with little or no difficulty.

(c) Stable quality at a level which will prevent long periods of 100% inspection.

II. Definitions of terms used in describing a Continuous Sampling Plan, as taken from MIL-STD-1235, are as follows:

(a) Clearance Number (i) - The clearance number, (i) is the number of consecutive conforming units in 100% Inspection that is needed prior to beginning inspection in a Sampling Frequency.

(b) Sampling Frequency (f) - The Sampling Frequency, (f) is the desired ratio between the number of units of product randomly selected and inspected at an inspection station and the number of units of product passing the inspection station during periods of Sampling Inspection. (f) is expressed as a Fraction of the Form 1/X, where X is an integer, which takes the value as shown in Table III.

(c) Homogeneity - All units of product are made to the same drawings, same drawing revisions, specification revisions and under stable conditions of production.

(d) Verifying Inspection - All characteristics which are 100% inspected by Production personnel will be re-inspected by Inspection personnel by Sampling at a frequency of (f) or higher. This will be termed verifying inspection.

(e) Production Interval - The production interval has been established by the cognizant government agency as units of product produced in a one shift period. The choice of the number of units of product or of duration of the production interval are made on the basis of production rate.

III. OPERATIONAL PLAN

(a) Inspection by individual characteristics with an (i) factor, (f) factor as required by Table II, Level II, using a 0.40% AQL for Major Characteristics, including special tests and 0.65% for Minor and Unclassified Characteristics.

TABLE II - SAMPLING FREQUENCY CODE LETTERS FOR SINGLE LEVEL CONTINUOUS SAMPLING PLANS

NUMBER OF UNITS OF PRODUCT PRODUCED IN A PRODUCTION INTERVAL	INSPECTION LEVELS			
	I	II		III
	CSP-1 & CSP-2	CSP-1 & CSP-2	CSP-A	CSP-1 & CSP-2
2-8	C	B	A'	A
9-25	D	C	B'	A
26-65	E	D	C'	B
66-110	F	E	D'	B
111-180	F	E	E'	C
181-300	G	E	F'	C
301-500	G	F	G'	D
501-800	G	F	H'	E
801-1300	H	F	J'	L
1301-3200	H	G	J'	F
3201-8000	I	H	K'	G
8001-22,000	J	I	L'	H
22,001-110,000	K	J	M'	I
110,001 - up	K	K	N'	J

(b) At the beginning of production the Inspection Station will be qualified by inspecting 100% of the units until the applicable "i" factor of consecutive pieces for each C/D have been accepted.

No defects will be allowed, however, production may screen parts before it reaches the Inspection Station without interference to the (i) factor which is being checked by Inspection.

(c) Once the Inspection Station has been qualified, the applicable factor will be used for Sampling Inspection.

TABLE III

VALUES OF "i" FOR CSP-1 PLANS

SAMPLING FREQUENCY CODE LTR.	"f"	AQL IN %													
		.015	.035	.065	.10	.15	.25	.40	.65	1.0	1.5	2.5	4.0	6.5	10.0
A	1/2	240	180	120	100	75	50	33	25	20	12	9	5	4	2
B	1/3	390	290	200	170	130	80	55	43	34	20	15	9	6	4
C	1/4	500	380	260	220	170	100	75	55	45	27	19	12	8	5
D	1/5	600	450	320	270	200	130	90	70	55	33	23	14	9	6
E	1/7	750	560	390	330	250	150	110	85	65	40	29	17	12	8
F	1/10	920	690	480	410	310	190	140	100	80	50	35	22	15	10
G	1/15	1110	840	590	500	380	230	170	130	100	65	43	27	18	12
H	1/25	1380	1040	730	620	470	290	210	160	130	75	55	34	22	15
I	1/50	1780	1340	940	800	600	370	260	200	160	100	70	42	29	19
J	1/100	2210	1660	1150	980	740	450	320	250	200	120	85	55	36	24
K	1/200	2630	1970	1370	1170	880	530	380	300	240	150	100	65	43	28
		0.12	0.16	0.23	0.27	0.36	0.59	0.83	1.08	1.35	2.20	3.09	4.96	7.24	10.70
		AQL IN %													

Sampling Inspection will be performed by Inspection personnel. The (f) factor will be recorded for Major and Minor Classes at the Inspection Station. All units passing an Inspection Station are considered accepted by AVCO Inspection. Sampling Inspection will continue until one of the following circumstances occur:

(1) Failure occurs on the (f) factor.

(2) A major change in the process occurs, i.e. Move Inspection Station, Major Tool Change, Drawing Change, which requires gage changes affecting CSP Plan, Specification Change etc.

(3) When the process is altered by innovations, material shortages, striked, re-tooling or interruptions other than those due to the end of the shift, day, working week, or holiday.

When one of the above occurs - (1) the Inspector will notify the operator of the rejection, (2) the Operator will stop the machine, (3) production personnel will investigate the cause of the deficiency and initiate and record corrective action, (4) the screening crew will be alerted to re-qualify the station (applicable (i) factor quantity of consecutive pieces without the recurrence of the defect). If defectives are found during the screening process they will be removed from the line and re-qualification beginning with Number 1. All parts passing the station during screening are considered acceptable if Item II, (d) is performed and acceptable to Inspection.

The limit number of requalification trials shall be three. At this time positive corrective action must be taken prior to further production. The length of a period of 100% Inspection is the number of consecutive units inspected conforming and non-conforming, without finding "i" consecutive conforming units.

IV. C/D's to be inspected are outlined by assembly operation on the attached pages.

V. Inspection results shall be recorded on attached forms.

CSP STATION #4

CENTERPLATE ASSEMBLY P/N 198714-F

C/D	Description of Characteristic	Dimension	Method of Inspection
	Major Class		
None Defined			
	Minor Class		
201	Evidence of poor workmanship, including excessive, missing or damaged components caused by assembly operations		Visual
	Unclassified Class		
501	Crimp improper (6 pl)	P/Note 2	Visual
	Special Test		
A	Arming of centerplate assembly	P/Note 4 .020 Min.	Benerson Test Machine
B	Retention check of firing pin spring on centerplate assembly	P/Note 5	198714-TF3-A
C	Separation test of hammerweight pin on centerplate assembly	P/Note 3 5 lb.	198714-TF2-A
D	Push-out of hammerweight assembly on centerplate assembly	P/Note 2 30 lb.	198714-TF1-A

NOTE: Perform tests in sequence shown above. Test "D" is a destructive test. Parts so tested shall not be returned to the lot.

REVISION 1: 9-24-73

PROGRESS REPORT

EQUIPMENT NAME: _____

PURCHASE ORDER NUMBER: _____

SWANSON ERIE SHOP ORDER NUMBER: _____

Period of time covered by report: From _____ To _____
Date report submitted: _____

Date Engineering effort started: _____
Date Engineering to be complete: _____
Estimated number of hours in Engr. task: _____
Percent complete as of report date: _____
Dollars expended as of report date: _____

Date fabrication to start: _____
Date fabrication to be complete: _____
Estimate of hours required for fabrication: _____
Percent hours complete as of report date: _____
Dollars expended as of report date: _____

Date purchased items required to start: _____
Date purchased items to be complete: _____
Estimate of dollars required for purchased parts: _____
Percent purchased as of report date: _____
Percent required as of report date: _____
Latest promise of any purchased items. _____

Date assembly to start: _____
Date assembly to be complete: _____
Estimated hours of assembly time: _____
Percent completed as of report date: _____
Dollars expended as of report date: _____

Expected ship date to Avco as of report date: _____

HARDWARE REQUIRED FOR MACHINE DESIGN, DEBUGGING & TRYOUT
CENTERPLATE ASSEMBLY MACHINE

Avco P.O. 041828
S/E S.O. 16488

Part No.	Description	Qty.	Shipped	Rec'd Vendor
198686	Centerplate	25	6-25-73	
198726	H'weight Sp.	25	6-25-73	
198727	H'weight Assy	25	6-25-73	
198728	Firing Pin	25	6-25-73	
198729	Firing Pin Sp.	25	6-25-73	

HARDWARE REQUIRED FOR TOOL DEVELOPMENT

Part No.	Description	Qty.	Shipped	Rec'd Vendor
198686	Centerplate	1000	8-17-73	
198726	H'weight Sp.	1000	8-17-73	
198727	H'weight Assy	3000	8-17-73	
198728	Firing Pin	1000	8-17-73	
198730	H'weight Pin	3000	8-17-73	
198729	Firing Pin Sp.	1000	*	NEED STRIP STOCK, NOT DETAIL PARTS.

HARDWARE REQUIRED FOR FEEDER BOWL TRYOUT

Part No.	Description	Qty.	Shipped	Rec'd Vendor
198686	Centerplate	5000		
198726	H'weight Sp.	5000		
198727	H'weight Assy	5000		
198728	Firing Pin	5000		
198730	H'weight Pin	5000		

HARDWARE REQUIRED FOR MACHINE TRYOUT

Part No.	Description	Qty.	Shipped	Rec'd Vendor
198686	Centerplate	10000		
198726	H'weight Sp.	10000		
198727	H'weight Assy	30000		
198730	H'weight Pin	30000		
198728	Firing Pin	10000		
198729	Firing Pin Sp.	10000		

APPENDIX III

INSTRUCTION MANUALS

198649-A1, Assembly Machine, Automated Process Inc.

198647-A1, Pinion Assembly Machine, Automated Process Inc.

198708-A2, Rotor Assembly Machine, Swanson-Erie Corp.

198751-A1, Escapement Assembly Machine, Swanson-Erie Corp.

901449-A1, Setback Pin and Spring Assembly Machine, Swanson-Erie Corp.

901448-A1, Fuze Final Assembly Machine, Swanson-Erie Corp.

198753-A1, Fuze Crimp and Mark Machine, Swanson-Erie Corp.

198751TF1, Escapement Assembly 100 Percent Spin Test Machine, Benerson Corporation

198751TF2, Escapement Assembly Spin Sample Test Machine, Benerson Corporation

198714TF4, Centerplate Assembly Spin Sample Test Machine, Benerson Corporation

APPENDIX IV

LIST OF EQUIPMENT DRAWINGS

INTRODUCTION

The drawing lists that follow are presented in three groups, according to vendor. Each machine is identified by an Avco number, which is given along with the machine description in the sequence listed as follows:

VENDOR: Automated Process Inc., Milwaukee, Wisconsin

Avco 198649-A1, Verge Assembly Machine

Avco 198647-A1, Pinion Assembly Machine

VENDOR: Swanson-Erie Corporation, Erie,Pennsylvania

Avco 198708-A2, Rotor Assembly Machine

Avco 198751-A1, Escapement Assembly Machine

Avco 901449-A1, Setback Pin and Spring Assembly Machine

Avco 901448-A1, Final Assembly Machine

Avco 198753-A1, Fuze Crimp and Mark Machine

VENDOR: Benerson Corporation, Evansville, Indiana

Avco 198751TF1, Escapement Assembly Test Machine

Avco 198714TF4, Centerplate Spin Sample Test Machine

Avco 198751TF2, Escapement Assembly Spin Sample Test Machine

VERGE ASSEMBLY MACHINE
AUTOMATED PROCESS INC.
AVCO 198649-A1 (DRAWING IDENTIFICATION)

SUBJECT: Detail Identification

For Avco numbering of details used on Automated Process Inc. Verge Assembly Machine, the following system was initiated.

1. All A.P.I. tracings were assigned a sheet number.
   Example: 1 thru 49 inclusive.

2. A.P.I.'s present detail number used.

3. The detail identification is now; Example: 198649-A1-1711.
   The 17 is the sheet number and the 11 is the detail number
   appearing on that sheet.

VERGE ASSEMBLY MACHINE
AUTOMATED PROCESS INC.
AVCO 198649-A1 (DRAWING IDENTIFICATION)
TAG NUMBER

A.P.I. STATION NO.	STATION NO.	DESCRIPTION
10	1	Load Arbor
20	2	Probe Verge Arbor
30	3	Loading of Verge
40	4	Probe Verge
50	5	Press Verge
60	6	Idle
70	7	Idle
80	8	Load Test 2.5 Pounds
90	9	Probe 0.125 Inch Dimension
100	10	Load Bushing
110	11	Press Bushing
120	12	Probe 0.175 Inch Dimension
130	13	Reject Station
140	14	Count
150	15	Eject Station
160	16	Empty Nest Check

PINION ASSEMBLY MACHINE
AUTOMATED PROCESS INC.
AVCO 198647-A1 (DRAWING IDENTIFICATION)
TAG NUMBER

A.P.I. STATION NO.	STATION NO.	DESCRIPTION
10	1	Feed and Place Pinion
20	2	Probe Pinion Presence
30	3	Feed and Place Starwheel
40	4	Position Starwheel
	5	Idle
	6	Idle
70	7	Probe Starwheel
80	8	Stake Starwheel
90	9	Test
100	10	Feed and Place Bushing
110	11	Press on Bushing
120	12	Probe 0.172 Inch Dimension
130	13	Unload Rejects
140	14	Count Good Parts
150	15	Unload Good Units
160	16	Probe Empty Nest

ROTOR ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 198708-A2 (DRAWING IDENTIFICATION)

SUBJECT: Detail Identification

For Avco numbering of details used on Swanson Erie Corporation Rotor Assembly Machine.

1. All Swanson Erie tracings were assigned a sheet number.

   Example: 1 thru 175 inclusive original; additional sheets start with sheet 176.

2. Swanson Erie present detail numbers used.

3. The detail identification - example: 198708-A2-107 - see list for drawing size and sheet number.

4. The standard items appear in the Swanson Erie lists for each station.

5. The purchase items appear in the Swanson Erie lists for each station.

6. Presently there are some "A" size detail drawings. They are in the file with the lists.

ROTOR ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 198708-A2 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	100	General Assembly
1	200	Load Sector Gear
2	300	Probe Sector Gear
3	400	Load Rotor & Probe
4		Idle
5	500	Staking Station
6	600	Pushoff Test
7	700	Detonator Load Station
8	800	Detonator Load, Magazine Feed
8	2500	Detonator Load Layout
8	900	Detonator Load Station Head & Probe
9		Idle
10		Idle
11	1000	Detonator Staking Station
12	1100	Push Test Station
13	1200	Unloading Station
14	1300	Unloading Station for Reject Parts
15		Idle
16	1700	Probe Empty Nest

ESCAPEMENT ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 198751-A1 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	100	General Assembly
1	200	Housing Escapement Load Station
3	300	Rotor Shaft Load Station
4	2600	Rotor Shaft Probe Station
5	400	Rotor Assembly Load Station
6	2500	Rotor Assembly Probe Station
7	500	Pinion Assembly Load Station
8	2300	Pinion Assembly Probe Station
9	600	Verge Assembly Load Station
10	2100	Verge Assembly Probe Station
11	700	Detent and Spring Load Station
11	2200	Nest Lift Cam
12	800	Detent and Spring Probe Station
13	900	Rotor Unarmed Position Probe Station
14	1000	Top Plate Load Station
15	1100	Top Plate Probe Station
16	1200	Ultrasonic Stake
17 & 18	1300	Unload Complete and Incomplete Assembly
19	1400	Empty Nest Probe Station
	1500	Oscillating Ring Assembly
	1600	Drive Specification Sheet
	1700	Timing Chart
	1900	Electrical Schematic
	2000	Name Plates

ESCAPEMENT ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 198751-A1 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	2400	Dereeler for Spring Wire
	3000	Additional Layouts Station No. 11

SETBACK PIN & SPRING ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 901449-A1 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	100	General Assembly
1	200	Escapement Assembly Load and Probe
2	300	Probe
3	400	Setback Pin Load and Probe
4		Idle
5	500	Setback Spring Load
6		Idle
7	600	Pulloff Test
8	700	Probe, Setback Spring
9		Idle
10	800	Unload Completed Parts
11		Idle
12	900	Unload Incomplete Parts
13		Idle
14	1000	Probe Empty Nest
	1100	Timing Chart
	1200	Pneumatic Diagram
	1700	Electrical Diagram

FINAL ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
EQUIPMENT NO. 20-GS-30
AVCO 901448-A1 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	100	General Assembly
1	200	Feed, Place, and Probe Body
2	300	Orient Body
3	400	Probe Orientation
5	500	Load Escapement Assembly
6	600	Probe Unarmed Position
7	700	Orient, Place, and Probe Centerplate
8	2100	Probe Centerplate
9	800	Crimp Body
10	900	Load O-Ring
11	1000	Probe O-Ring
14	1100	Feed, Place, and Probe Actuator
16	1200	Feed, Place, and Probe Ogive
17	2200	Probe Final Assembly
18/19	1300	Unload Complete or Incomplete Assembly
20	1400	Empty Nest Probe
	1500	Timing Chart
	1600	Specification Sheet
	1700	Oscillating Ring Assembly
	1800	Electrical
	1900	Pneumatic Diagram
	2000	Nest Assembly

CRIMP & MARK FUZE ASSEMBLY MACHINE
SWANSON ERIE CORPORATION
AVCO 198753-A1 (DRAWING IDENTIFICATION)

STATION NO.	ASSEMBLY DRAWING	DESCRIPTION
	100	General Assembly
	200	Nest Assembly
1	300	Load Station
3	400	Crimp and Height Check
7	500	Marking Station
13	600	Probe Empty Nest
	700	Fuze Assembly List and Transfer Mechanism Cam Assembly
	800	Timing Chart
	900	Pneumatic Diagram
	1000	Electrical

ESCAPEMENT ASSEMBLY TEST MACHINE
BENERSON
AVCO 198751TF1 (DRAWING IDENTIFICATION)

SUBJECT: Drawing Identification

For Avco numbering used on the Benerson Escapement Assembly Test Machine the following system was initiated.

1. All Benerson tracings were assigned an Avco sheet number appearing in margin below title block. Example: 1 thru 107 inclusive originally - additional sheets to start with 108.

2. All stations assigned a number. Example: 198751TF1-100 is layout and Bill of Material for station No. 1.

3. Present Benerson detail number used.

4. For the identification and the marking of details the following method is to be used. Example: 198751TF1-A53
198751TF1 - Basic number
A - symbol indicates station No. 1 (see symbol sheet)
53 is the detail number.

5. For the identification and the marking of subassemblies, the following method is to be used. Example: 198751TF1-SA-301
198751-TF1 - Basic Number
SA - Symbol for Subassembly (see symbol sheet)
301 - Subassembly for station No. 3.

ESCAPEMENT ASSEMBLY TEST MACHINE
AVCO 198751TF1 (DRAWING IDENTIFICATION)
SYMBOL'S AND STATION

AVCO SYMBOL	AVCO	DESCRIPTION
	-10	Installation Drawing
	-20	Tooling Plate
	-30	Reciprocating Plate
	-40	Dial Plate
	-50	Cam Timer
		Base Machine
	-70	Base Check Unit
	-80	Carrier
A	-100 Station No. 1	Feed and Place Escapement Assembly
B	-200 Station No. 2	Check for Safe Position of Rotor
C	-300 Station No. 3	Spin Test @ 3750 Revolutions Per Minute and Check Arming Time
D	-400 Station No. 4	Orient Assembly Radially
E	-500 Station No. 5	Check for Oriented Carrier
F	-600 Station No. 6	Unload Rejected Assemblies Into One of Three Magazines
G	-700 Station No. 7	Rotate to Re-Safe Good Assembly
H	Station No. 8	See Layout 198751TF1-200, Station No. 2
J	-900 Station No. 9	Spin Test Assembly @ 1500 Revolutions Per Minute for No-Arm
K	Station No. 10	See Layout 198751TF1-400,Station No. 4
L	Station No. 11	See Layout 198751TF1-500,Station No. 5
M	Station No. 12	See Layout 198751TF1-200,Station No. 2
N	1300 Station No. 13	Unload Rejected Assemblies Into One of Two Magazines
P	1400 Station No. 14	Unload Good Assemblies

ESCAPEMENT ASSEMBLY TEST MACHINE
AVCO 198751TF1 (DRAWING IDENTIFICATION)
SYMBOL'S AND STATION

AVCO SYMBOL	AVCO	DESCRIPTION
R	1500 Station No. 15	Check for Empty Carrier
	1600	Electrical
	1700	Pneumatic System
	1800	Lubrication System
SA		Subassembly

ESCAPEMENT ASSEMBLY TEST MACHINE
BENERSON
THEIR DRAWING S.O.
AVCO 198751TF2 (DRAWING IDENTIFICATION)

LAYOUT NO. 10
TWO SPEED SPIN TEST MACHINE

BENERSON SHEET NO.	AVCO SHEET NO.	SIZE	DESCRIPTION
1	1	R	Assembly, Bill of Material
2	2	R	View B-B, C-C, D-D
3	3	D	Details 46, 51, 54, 98
4	4	D	Details 18, 48, 49, 59, 64, 65, 91, 92
5	5	D	Detail 19
6	6	D	Details 7, 11, 28, 29, 63
7	7	D	Details 10, 12, 17, 66, 67, 68, 69, 70, 90, 99
8	8	D	Details 45, 56, 57, 106, 125
9	9	D	Details 14, 53, 107, 115, 118, 121
10	10	D	Details 47, 72, 73, 77, 76, 94, 108, 123
11	11	D	Details 97, 116
12	12	D	Details 38, 39, 84, 85, 87, 88, 126
13	13	D	Detail 4
14	14	D	Detail 27
15	15	D	Details 6, 111, 112
16	16	D	Detail 95
17	17	D	Details 3, 24, 25, 31, 104, 105, 114
18	18	D	Details 20, 102, 109
19	19	D	Detail 101
	29	C	Detail SA 101
	30	B	Detail 61

CENTERPLATE SPIN TEST MACHINE
BENERSON
THEIR DRAWING S.O.
AVCO 198714TF4 (DRAWING IDENTIFICATION)

TWO SPEED SPIN TEST MACHINE FOR CENTERPLATE ASSEMBLY

BENERSON SHEET NO.	AVCO SHEET NO.	SIZE	DESCRIPTION
1	1	R	Assembly, Bill of Material
2	2	R	Section A-A, B-B, C-C
3	3	R	Detail 2
4	4	D	Details 14, 15, 20, 50
5	5	D	Details 16, 29, 33, 35
6	6	D	Details 1, 11, 12, 30
7	7	D	Details 4, 7, 8, 21, 27
8	8	D	Details 26, 40
9	9	D	Details 23, 52, 54
10	10	D	Details 6, 53, 55
11	11	D	Detail 42

APPENDIX V

OPERATING INSTRUCTIONS
FOR
BENERSON ARMING TIME DELAY MACHINE

PART—ESCAPEMENT ASSEMBLY—198751

REQUIREMENTS—NOTE 3—Safety Test: Rotor gear must not move to armed position when assembly is spun around its axis to a rotational speed of 1500 RPM.

NOTE 5—Rotate escapement assembly at 3750 RPM and measure arming time. Acceptable limits .310 seconds max. and .220 sec. min.

DESCRIPTION

Station No.	Operation
1	Receive assembly from in line track, turn over (180°F), push in position and down into nest.
2	Probe for assembly and safe position of rotor.
3	Spin assembly 3750 RPM and check arming time.
4	Radially orient assembly nest.
5	Probe for proper orientation.
6	Unload rejects (1st mag. over .31 sec., 2nd mag. under .22 sec., 3rd mag. not armed).
7	Rotate assembly to resafe rotor position.
8	Probe for assembly and safe position of rotor.
9	Spin assembly 1500 RPM and check for No Arm.
10	Radially orient assembly nest.
11	Probe for proper orientation.
12	Probe for assembly and safe position of rotor.
13	Unload rejects (1st mag. rotor unsafe at Station 12; 2nd mag. unsafe at Station 8).

Station No.	Operation
14	Unload accepted assembly.
15	Probe for empty nest.

TROUBLE INDICATOR

Indicates	Correction
Station 2	Remove part from station.
3	Remove part from station.
9	Remove part from station.
15	Remove part from station.
3	Jog to next station before removing part.
9	Jog to next station before removing part.
6	Empty reject tube before starting.
13	Empty reject tube before starting.

OPERATE

1. Turn on master electric switch located on panel.
2. Open air cock and turn on "Ross" air valve to supply air.
3. Reset counters.

ALLOW A MINIMUM OF 15 MINUTES WARM UP

4. Push "MASTER START" button.
5. Turn "JOG SWITCH" to "RUN" position.
6. Push "RESET" button on Machine Control Panel.
7. Push "RESET" button on Timer Control Panel.
8. Check for adequate supply of parts in track.
9. Push "CYCLE START" button. Machine is now running and will cycle automatically.

MACHINE WILL STOP IF—

1. Three (3) parts missing from Station No. 2.
2. Trouble indicator shows signal indicating station trouble.
3. Machine guard/doors open.

TO RESTART—Repeat Items 4 thru 9 above.

REJECTS

Station 6—Low Time
High Time
No Time

Station 13—Non-Arm
Re-Safe

ACCEPTED PARTS ARE AUTOMATICALLY EJECTED FROM STATION 14.

APPENDIX VI

OPERATING INSTRUCTIONS
FOR
ESCAPEMENT SAMPLE TEST MACHINE

PART—ESCAPEMENT ASSEMBLY—198751

REQUIREMENT—NOTE 4—Arming Test: Rotor gear must move to armed position when assembly is spun around its axis to a rotational speed of 2900 RPM maximum.

DESCRIPTION—This machine has two (2) stations. The left station is for spin testing the escapement assembly and the right station is for returning the rotor to the safe position (resafing).

INSTRUCTIONS

1. Turn on master electrical switch located on main panel.
2. Open air cock and turn on "Ross" air valve to supply air (60-70 psi regulator pressure).

ALLOW A MINIMUM OF 15 MINUTES WARM UP

3. Turn selector switch on right hand station to "2950".
4. Push "MASTER START" button. Motor is now running.

FOR TESTING—(LEFT STATION)

5. Pull "T" handle back and press reset button before releasing.
6. Load part in nest.
7. Move "T" handle forward until shot pin comes up and engages "T" handle.
8. Part is now in position.
   PUSH GREEN PALM BUTTON to engage head and spin part.
   Machine will automatically cycle and "T" handle will release.
9. UNLOADING—Pull "T" handle all the way back and remove part.
10. Before releasing "T" handle, push "RESET" button for next test.
11. Observe part for position of rotor—MUST BE ARMED.
12. Load another part and recycle.

FOR RESAFING—(RIGHT STATION)

1. Open door.

2. Place tested part in nest.

3. Close door.

4. Push "RESET" button.

5. Push YELLOW PALM BUTTON and machine will automatically cycle to resafe part.
(Resafing is complete when "RESAFE HOME" light comes on and head retracts.)

6. Open door and remove part when "RESAFE HOME" light comes on.

APPENDIX VII

CALIBRATION PROCEDURE
FOR
CENTERPLATE ASSEMBLY SAMPLE TEST MACHINE

EQUIPMENT REQUIRED:

1. Digital Voltmeter D.C.
2. Electronic Counter
3. Gage Blocks

A. Speed Check on Spindle

1. Utilize the Electronic Counter connected to the magnetic pick-up output jack. Check the two spindle speeds as follows:

a. 1000 $^{+\ 0}_{-25}$ RPM

b. 3000 ± 25 RPM

B. Linearity Check of LVDT (Linear Variable Distance Transformer)

1. Determine operating range of LVDT by running a few parts and utilizing gage blocks, position LVDT deflection in this range. Be sure to utilize one separate 0.050 gage block in this set-up.

2. Connect digital voltmeter to the output jack on Pcb-214 amplifier-demodulator printed circuit board. Read digital voltmeter with 0.050 gage block inserted. Record reading. Read digital voltmeter with 0.050 gage block removed. Record reading. Subtract first reading from second reading. Difference should be 500 ± 5. This sets the LVDT linearity to be 0.500 volts for 0.050 inch change in deflection.

C. Calibration of Meter Assembly

1. With gage blocks minus the 0.050 block connect digital voltmeter to high side of meter multiplier circuit on meter assembly printed circuit board, first to input multiplier.

   Position selector switch to "INPUT" position. Adjust input adjust pot until Schaevitz Dvm reads the same as the Dvm.

2. With the toggle switches for difference (B-A, C-A) away from the markings, continue above placing Dvm input progressively from A to B to C and selector switch in turn to A, B, C and adjust Channel A, B, C. Adjust until meters agree as in 1.

3. Connect digital voltmeter to high side of meter multiplier circuit for C-B reading. Place C-B switch to C-B and adjust pot until Dvm and Schaevitz meter agree.

D. Calibration of Sample and Hold Amplifiers

1. Connect the digital voltmeter to the output jack on PCB 433 amplifier demodulator. Place selector switch to A, press sample and hold button and adjust pot on PCB-318A until Schaevitz meter and Dvm agree.

NOTE: Sample and hold button must be actuated between each adjustment.

2. Sections B and C follow with appropriate switch settings.

E. Calibration of Difference Amplifiers

1. Utilize the gage blocks to position the transducer with the 0.050 gage in place, position selector switch to "A" and toggle switch B-A in off position, press the sample and hold button. Position selector switch to "B", remove 0.050 block and press sample and hold button "B". Actuate B-A toggle switch and adjust gain pot on PCB 424 (B-A) until Schaevitz Dvm reads 500. Recheck.

2. Use same procedure as in "1" to check C-A difference amplifier.

APPENDIX VIII

OPERATING INSTRUCTIONS
FOR
CENTERPLATE SAMPLE TEST MACHINE

PART—CENTERPLATE ASSEMBLY—198714

REQUIREMENT—NOTE 4—The firing pin must move .020 min. at 3000 RPM under 30 ± 1 gram load and may move .020 max. at 1000 RPM under 30 ± 1 gram load.

INSTRUCTIONS

1. Turn on master electrical switch on main panel.
2. Open air cock and turn on "Ross" air valve to supply air (60 - 70 psi regulator pressure).
3. Check (2) air gages located to the right of spindle.

   The left gage to be set at 7 psi.
   The right gage to be set at 73 in. -H_2O.
4. On digital readout unit, turn left toggle switch to right and right toggle switch to left. This insures proper display.

   ALLOW A MINIMUM OF 15 MINUTES WARM UP
5. Push "MASTER START"—Motor is now running.
6. Turn selector switch to "AUTOMATIC".
7. Load part in nest.
8. Push "RESET" button.
9. Push PALM buttons—hold palm buttons until head is locked in.
10. Machine will cycle automatic through both test speeds.
11. Read firing pin movement on digital display.

    Left display — .020 max. (.xxxx Display)
    Right display — .020 min. (.xxxx Display)
12. Test is complete—remove part and place in accept/reject container.
13. Repeat Steps 7 thru 12 for testing additional parts.

APPENDIX IX

M550 FUZE ASSEMBLY PRODUCTION BY AUTOMATED LINE

Contract DAAA21-72-C-0852 for production of 1.5 million M550 fuzes was awarded to Avco Precision Products Division while the Advanced Production Engineering of the M550 Fuze, and procurement of an automated line, was in progress. Fuze production from September, 1973 through February, 1974 is shown on the following table.

Month	Schedule	
September 1973	0	32,432
October	20,000	62,422
November	100,000	202,524
December	150,000	187,514
January 1974	250,000	254,562
February	300,000	303,377

The need for the Cartridge, 40mm, HEDP, M433, of which the M550 Fuze is a part, became so acute in late 1973 and early 1974 that in many instances desirable improvements to the automated equipment were delayed in the interest of obtaining continuous limited production. As a result, some of the equipment revisions have been tabled until after the current production contract is completed. Therefore the maximum production rate of the line, even with manual banking between machines, was not fully realized.

Another restriction that limited total output of the line was the Government Furnished Equipment for the centerplate assembly. The best output for this equipment is about 800 assemblies per hour. Therefore with this equipment operating on a 3-shift basis and the prototype fuze line operating on two shifts, centerplates could not be produced at a rate sufficient to meet the production requirements of the rest of the line. When the new centerplate assembly machine now being built by the Swanson-Erie Corporation is available, the line should be balanced, because it will have a capability comparable to the other automated assembly machines in the prototype line.

Extrapolating beyond February, 1974, the planned production rate through June, 1974 is 300,000 fuzes per month on a 2-shift, 8-hour, 5-day week basis. Considering that the machines are not being taken out of production long enough to optimize functioning through improvements and revisions, and that hand banking between machines is relatively inefficient, the rate of 300,000 per month was selected as a practical figure under the limiting conditions indicated. At times, individual machines have demonstrated a capability of about 400,000 fuzes per month on a 2-8-5 basis, but this average rate cannot be sustained unless automatic banking facilities are provided.

The desired production rate for the prototype line is 500,000 M550 Fuzes on a 2-8-5 basis. To meet this, the following are considered mandatory:

- o One additional Escapement Assembly Machine.
- o One additional 100% Arming Time Delay Machine.
- o Automatic subassembly banking, located
  1. Prior to escapement subassembly.
  2. After escapement subassembly.
  3. Prior to fuze final assembly (less crimp and mark).

In addition, it would be good insurance to provide an additional Fuze Final Assembly Machine, because its complexity is about equal to that of the Escapement Assembly Machine, making it more susceptible to down time for minor or major causes.

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13. ABSTRACT

This is the final report on progress achieved on the M550 Fuze Produet Improvement Program, Contract No. DAAA21-72-C-0566, during the period from April 1972 through February 1974.

The objeetive of the program was to design, develop, fabricate and debug a prototype M550 Fuze assembly line that will be capable, when balanced, of producing 250,000 fuzes per month on a 1-8-5 shift basis. This contraet did not require that the line be balanced for a true 1-8-5 shift basis at this time.

The prototype line was acquired and installed, with production beginning on a separate contract almost immediately.

Appendices are included eovering a verbal description of each machine's function; a sample purchase description; listing of operation and maintenanee manuals, and a list of drawings for the assembly and test maehines; operating instructions for the test maehines; and a comment on automated line production through February 1974 and suggested improvements.

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